Agriculture

Chapter 1

Short Answers

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22

This chapter contains:

- Agriculture and Allied Sector
- An Aerial View of Indian Agriculture
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- Transformation of Agriculture
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- Agriculture Pricing Policy

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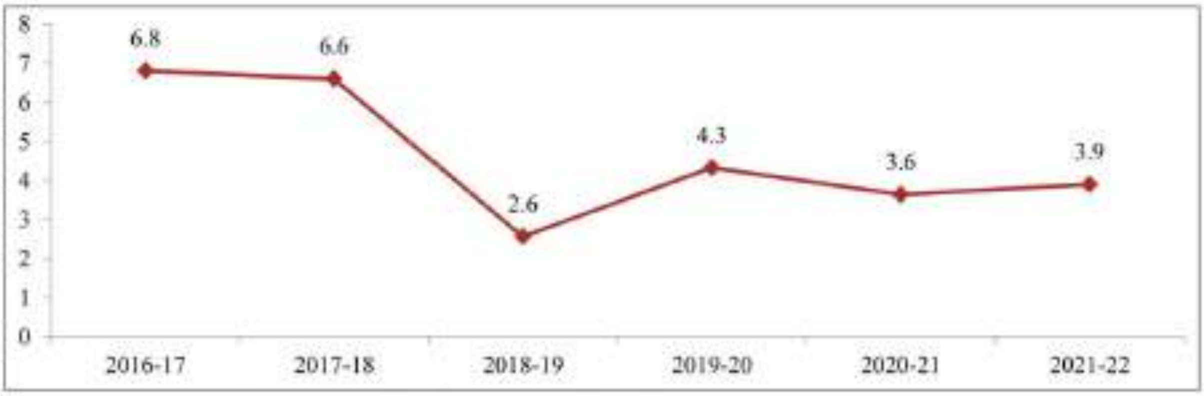
1. Agriculture and Allied Sector

AGRICULTURE SECTOR

Figure 1: Growth of Agriculture and Allied Sectors (per cent)



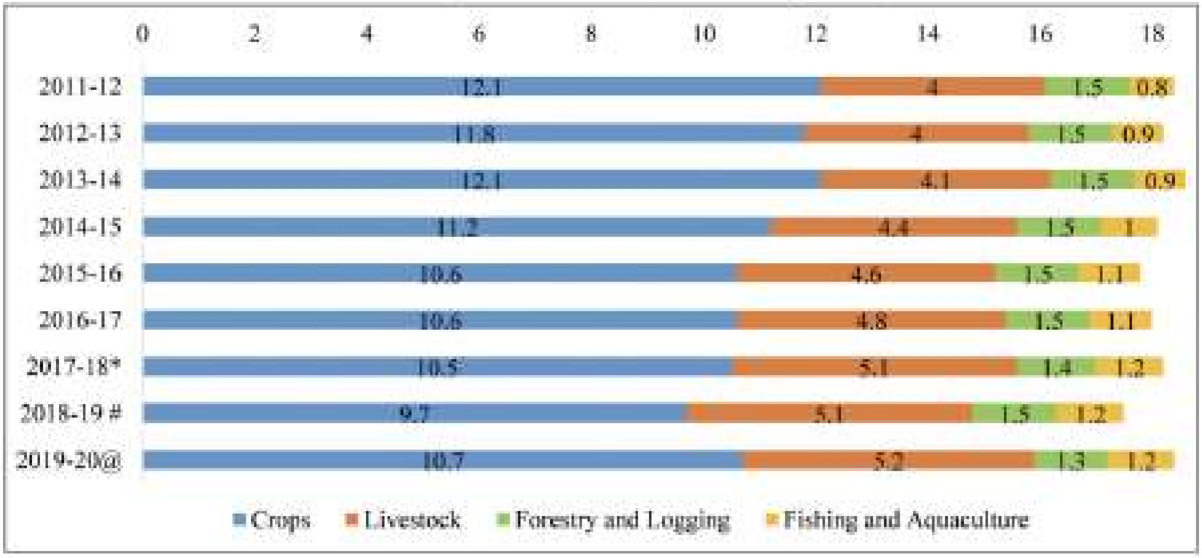
Source: First Advance Estimates of National Income, 2021-22

1. The Agriculture sector which accounts for 18.8% of Gross Value Added (GVA) of the country in 2021-22 has experienced buoyant growth in the past 2 years. It grew at 3.9 per cent in 2021-22 and 3.6 per cent in 2020-21 showing resilience in the face of COVID-19 shock states the Economic Survey 2021-22
2. As per Census 2011, about **54.6% of the total workforce** of the country is still engaged in agriculture and allied sector activities.
3. The Gross Capital Formation in the agricultural sector relative to the GVA in the sector is showing a fluctuating trend in sync with the variation in private sector investments, whereas the public sector investments have remained stable at 2-3 per cent over the years. The Survey 2021-22 suggests "*higher access to institutional credit to farmers and greater participation of the private corporate sector*" may improve private sector investment in agriculture.
4. As per 2ndAdvance Estimates for 2021-22, total **Foodgrains** production in the country is estimated at record 316.06 million tonnes which is higher by 5.32 million tonnes than the production of foodgrain during 2020-21. Further, the production during 2021-22 is higher by 25.35 million tonnes than the previous five years' (2016-17 to 2020-21) average production of foodgrains.
5. India is a **net exporter of agri-products**, and major export destinations include the USA, Saudi Arabia, Iran, Nepal, and Bangladesh.
    1. Major agricultural exports from India include marine products, basmati rice, buffalo meat, spices, non-basmati rice, raw cotton, oil meals, sugar, castor oil, and tea.
    2. India's total agri-export basket accounts for a little over 2.5% of world agri-trade.

ALLIED SECTORS: ANIMAL HUSBANDRY, DAIRYING, AND FISHERIES SECTOR

1. Livestock sector contributed 4.35% of total GVA in 2019-20. Development of livestock sector has led to improvement in per capita availability of milk, eggs and meat.
2. India is ranked 1st in milk production contributing 23 per cent of global milk production. Milk production in the country has grown at a compound annual growth rate of about 6.2 per cent to reach 209.96 million tonnes in 2020-21 from 146.31 million tonnes in 2014-15
3. According to FAOSTAT production data (2020), India ranks 3rd in Egg Production and 8th in meat production in the world. Egg production in the country has increased from 78.48 billion in 2014-15 to 122.11 billion Nos. in 2020-21. The per capita availability of egg is at 91 eggs per annum in 2020-21. Meat production in the country has increased from 6.69 million tonnes in 2014-15 to 8.80 million tonnes in 2020-21.
4. India is the second largest fish producing country in the world accounting for 7.56% of global production. It contributes about 1.24% to the country’s GVA and over 7.28% to the agricultural GVA.

Figure 4: Percentage Share of GVA of Crop & Allied Sectors in Total Agriculture GVA (at current prices)



Source: Based on data of DAFW.

FOOD PROCESSING SECTOR

During the last five years ending 2019-20, Food Processing Industries (FPI) sector has been growing at an average annual growth rate of around 11.18%. The sector constituted as much as 9.87% of GVA in manufacturing in 2019-20 at 2011-12 prices. According to the latest Annual Survey of Industries (ASI) for 2017-18, the total number of persons engaged in registered food processing sector was 19.33 lakh.

GENERAL ISSUES WITH AGRICULTURE SECTOR

Agriculture sector in India faces a multitude of challenges like:

Small and fragmented land holdings: As per the Agriculture Census 2015-16, the size of average landholding is a mere 1.08 hectares.

Disguised unemployment: Dependency on agriculture is on the rise due to lack of alternative employment opportunities and burgeoning population resulting in disguised unemployment.

Seeds: Good quality seeds are out of reach of the majority of farmers, especially small and marginal farmers mainly because of exorbitant prices of better seeds.

Manures, fertilizers, and pesticides: Excessive use of fertilizers has led to depletion and exhaustion of soils resulting in their low productivity.

Irrigation: Irrigated area accounts for nearly 48.8% of the 140 million hectares (mha) of agricultural land in India. The remaining 51.2% is rainfed. As a result, much of our agriculture is dependent on monsoon, which is often uncertain, unreliable, and erratic.

Mechanization: Little or no use of machines is made in ploughing, sowing, irrigation, thinning and pruning, weeding, harvesting, threshing, and transporting the crops. It results in huge wastage of human labor and low yields per capita labor force.

Soil erosion: Large tracts of fertile land suffer from soil erosion by wind and water, leading to infertility.

Agriculture marketing: In the absence of sound marketing facilities, farmers have to depend upon local traders and middlemen for the disposal of their farm produce which is sold at a throw-away price. It is these middlemen and local traders who dominate the marketing and trading of agricultural produce. They buy the produce at a lower price from the distressed farmers and sell it at a higher price to the consumers, thus reaping the majority of the profits and the producer does not derive similar benefit. The **Rural Credit Survey Report** remarked that the producers, in general, sell their produce at an unfavorable place and at an unfavorable time and usually they get unfavorable terms.

Debt trap: In the absence of bank credit, farmers, especially small and marginal ones, are forced to take loans from local moneylenders who often charge very high interest rates from them. This pushes the farmers into a debt trap as they are unable to repay the costly loans.

Inadequate storage facilities: In the absence of adequate storage facilities, farmers are compelled to sell their produce immediately after the harvest at the prevailing market prices which are bound to be low. Such distress sale deprives the farmers of their legitimate income. Absence of storage facilities also leads to post-harvest losses.

Inadequate transport: One of the main handicaps with Indian agriculture is the lack of cheap and efficient means of transportation. Even at present, there are lakhs of villages which are not well connected with main roads or with market centers. Under these circumstances, the farmers cannot carry their produce to the main market and are forced to sell it in the local market at a low price.
Global scenario: Global slump in agricultural prices has led to non-remunerative pricing for farmers.

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2. An Aerial View of Indian Agriculture

Indian agriculture is akin to huge aeroplane without fuel. Can it fly? The facts that agriculture engages 43 percent of total work-force in the country, 60 percent of country's total land area under cultivation, and uses 83 percent of fresh water justify the analogy of 'huge aeroplane'.

India is net food exporting country after feeding 1.35 billion people, yet farmers income levels have not increased as expected. Clearly, something is missing in our agriculture. We need to find out that missing 'fuel' which would take our agriculture to new heights.

This session seeks to give an aerial view of the country's agriculture and how to make it profitable, that is say that both 'diagnostic' and policy imperatives will be briefly delved.

Importance of agriculture is to be viewed not from the perspective of just food security but it goes far beyond this. It has the ramification on National sovereignty. Wheat aid to India in mid-1960s, just as an example, was sought to be used as an instrument to arm twist a sovereign country.

This example amply illustrates the possibility of National interest getting compromised in the event of heavy dependence on other countries for key staple food supplies and hence the importance of food security. India moved from import-dependence to self-sufficiency and then to a net food exporting country and the rest is history.

The broad objective of the agri policy is to bring about a qualitative and positive change in the lives of the farmers of India. How can we move forward to achieve this objective? Let me briefly share my thoughts under 9 broad categories:

I. Re-orienting Policy Framework and Governance

i. 'Agriculture, Irrigation and Rural Development' is one of three constituents of 'Aspirational India' theme of Union Budget 2020.
ii. Ensuring food security to ever increasing population by increasing agriculture output has been the cornerstone for development of the agriculture sector in India since mid-1960s. This has been broadly accomplished.
iii. Implicit in the strategy was an underlying assumption that benefits of augmentation in production and productivity would have trickle-down effect on farmers' welfare in terms of their income levels. However, this assumption has eluded the Nation.
iv. Therefore, policy framework is being reoriented to explicitly bring farmers welfare to the centre of development agenda.

II. Diversification to High Value Agriculture

One percentage growth in agriculture is at least 2 to 3 times more effective in reducing poverty than the same growth coming from non-agri sectors. Given rising income levels, consumption patterns in general are shifting away from cereals towards high-value commodities. India can ill-afford to continue with laying emphasis on increasing production of traditional crops which may not necessarily translate into augmentation of farmers' income. The focus on diversification to high value crops and the adoption of emerging technology are being emphasized.

III. Agriculture Marketing, and Strengthening Infrastructure

Marketing system helps to direct and crystallize demand, develop capacity to ensure operational and pricing efficiencies. Marketing efficiency is to be achieved by reducing dispersion between prices paid by consumers and those received by farmers. Often, farmers suffer from distress sales. Due to gaps in the storage and marketing infrastructure, poor handling practices, lack of proper storage infrastructure and absence of post-harvest protocols, the country suffers huge post-harvest losses. The reforms in storage, integrated cold chain, warehousing, marketing and processing have been initiated, the bottlenecks in grant of agri-credit by RRBs are being removed.

IV. Stable Agricultural Trade Policy

- **i.** A cogent agriculture trade policy ought to be rooted in the long term[1] food and nutritional security concerns of the country alongwith promoting and integrating farmers with the global market.
- **ii.** However, the instrument of international agri-trade is often used to control prices in the domestic market, in reaction to short term supply bottlenecks.
- **iii.** Such a knee jerk reaction to restrict or impose an outright ban on exports is an implicit tax on farmers and such an approach adversely impacts farmers' incomes.
- **iv.** Major bottlenecks in enhancing agri-exports need to be removed to make it stable and more rational trade policy.

V. Sustainability Concerns in Agriculture

- **i.** The paradigm of food deficiency and growing population that obtained in the 1960s led to adoption of the technology encapsulated as Green Revolution. Though this imparted a state of food security to the country, it was resource extractive in terms of depleted water table, deficiency of several soil nutrients, land degradation. This necessitated increasingly intensive input usage to realise the same yield per unit.
- **ii.** This situation is compounded by the climate change that has already begun to show deleterious impacts. Given the certainty of climate change, mitigation, coping and adaptation measures also deserve due importance in the production strategy.
- **iii.** the agricultural eco-system, necessary sustainability factors, countering the existing stresses on soil, water and also the larger ecology issues need to be fixed.

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[1] A long term usually takes 3 years view as in case of Foreign Trade Policy announced by the Department of Commerce

VI. **Risk Management in Agriculture**

i. Agricultural system is exposed to various risks which are closely associated with damage or loss in physical or financial terms. Such risks are linked to monsoon and markets. Risk mitigation normally requires thought on both financial cover and physical actions. The ability to take a risk, or challenge new frontiers is highly limited in the case of farming communities.

ii. It is imperative to prepare the farmer to be ready to face risks, negotiate and manage them appropriately to minimise the negative outcomes.

iii. The strategies that help build resilience and capacity to recover from challenges resulting from *natural calamities*, as well as to counter the risks that result from man-made actions, information asymmetry, markets and marketing.

VII. **Empowering the Farmers**

i. In today's situation, where the majority of farmers generate increasing amount of marketable surplus, particularly in case of certain commodities, there is strong demand for knowledge and assistance in the post-production phase.

ii. At the same time, climate change led vagaries require renewed attention to the associated shifts in risks, which include changes in seasonality patterns, nature of pests and diseases, crop planning and input requirements.

iii. A suitable architecture for the extension system that will meet the changing demands of a market led and income-centric agricultural economy needs to be developed.

iv. And the optimal blend is needed between manpower and technology based extension.

VIII. **Doubling Farmers' Income**

i. A paradoxical situation prevails in India where per capita income is rising, production of foodgrains rising alongwith increasing number of malnutrition, stunted children.

ii. Given huge disparities in income levels in agriculture and non-agriculture sectors, the need to reorient governance to place farmers' prosperity at the centre of the development agenda is widely felt.

iii. For the purpose of meeting the national agenda to doubling farmers' income, there is a need to direct the scientific research into areas that can bring income gains in the comparatively shorter term for all agriculturists, especially for under developed and poorly resourced farmers.

iv. The focus is to move from the '**Science of Discovery' to 'Science of Delivery'**.

v. Linking farmers with optimal demand and assisting the marketing system to develop optimised supply chain operations are critical areas where technologies can add great value to the farmer.

vi. A systems approach to develop farms and farmers as enterprises be promoted.

IX. **Agri-Policy**

i. Agricultural sector, huge in size and complex in nature, cuts across domains, and therefore, the approach to it cannot remain in a narrow prism of a traditional farmers' discipline.

ii. The prime objective of agricultural development is being moved from production centric to income augmentation.

iii. This requires a multitude of cross-domain considerations in bringing a holistic and long lasting strategy to the agricultural sector.

iv. Indian Agrarian societies will find renewed global predominance, as the world faces growing populations and industrial demands, and this will happen in the backdrop of climate change. We need to redefine the agriculture and approach the sector from the perspective of its primary actors namely the farmers.

v. **To summarize** what we discussed in this video, agriculture sector cuts across all socio-economic backdrops, and therefore, the approach to it requires a multitude of cross-domain considerations in bringing a holistic and long lasting strategy to the sector.

vi. India's remarkable turnaround of her agriculture from food importing to self sufficiency and then net food exporting country without concomitant increase in the income level of farmers is a paradox of sorts.

vii. Therefore, the farmer's welfare has to be brought to the centre of development agenda. Only then, Indian Agrarian societies can find renewed global predominance.

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3. Overarching Contours of Agriculture

Agriculture is the life blood of Indian economy. At one level, India's agri-strategy has been successful in the sense that the country moved from import-dependence to self-sufficiency and then to a net food exporting country, at another level, the strategy by-passed farmers' welfare as reflected in their low income levels. Clearly, something is missing in our agriculture. We seek to figure out that crucial missing link that has potential to take our agriculture to new heights.

Why is Agriculture Critical?

Food Security: To feed 1.35 billion populations, that is still growing and likely to cross China's population by 2027;

Economic Access to food: An average Indian household still spends more than half of its expenditure (MPCE) on food and bottom 30% of the population spends more than 60% on food; to contain food inflation on long term basis;

Poverty: 26% of the population is BPL and 43% of children under 5 years being underweight;

Labour Productivity: 43% of India's work-force contributes 15% of Agri-GDP; question of labour productivity and livelihood;

Importance of agriculture is to be viewed not from the perspective of just food security but it goes far beyond this. It has the ramification on National sovereignty. Wheat aid to India by US in mid-1960s, just as an example, was sought to be used as an instrument to arm twist India to support them in their war against a third country. This example amply illustrates the possibility of National interest getting compromised in the event of food dependence and hence the importance of food security.

Ensuring food security to ever increasing population of India by increasing agriculture output has been the cornerstone for development of the agriculture sector in the country since mid-1960s. Prior to this, the foodgrains in the country were made available mainly through imports of wheat under Public Law 480 (PL 480) food aid from the USA. The country's position was akin to 'ship to mouth', given the country's heavy dependence on imports when these imports reached their peak in the mid-1960s. Then set of innovations in terms of high-yielding varieties (HYV) of seeds, along with associated innovations in agricultural practices and marketing, often encapsulated in the term "Green Revolution," were introduced and the results of the process were remarkable. This strategy has been successful in the sense that India moved from import-dependence to self-sufficiency and then to a net food exporting country. However, the strategy did not explicitly promote farmers' welfare with the result that their income remained low, notwithstanding the fact that India's foodgrains production increased 3.9 times during last 53 years (1965-66 to 2018-19). The disparities in income levels in agriculture and non-agriculture sectors are huge.

Indian Agriculture can be divided into 5 Transitory phases:

1. **Phase I : Pre-Green Revolution Period** (1950-65) which was characterized by Deficit in food production And the Approach adopted to deal with it was to design Marketing system to handle deficit, regulate trade and manage food security. Attempt was made to make food available through imports, and large scale investment in irrigation and power. Some reforms like enactment of Zamindari Abolition Act (1950), organisation of agriculture and animal husbandry on modern-scientific lines, were initiated.

2. **Phase II: Green Revolution Period (1965-80),** India learnt her lesson hard way and realised how vulnerable a country can become as a consequence of heavy dependence on imports of key commodities. Self Sufficiency in Food grains, start of 'Operation Flood' were placed in the centre of development agenda.

'Birth of twin sisters' namely CACP (Commission on Agriculture Costs and Prices) and Food Corporation of India (FCI) in January 1965 ushered the period of fixation of Minimum Support prices (MSP) and public procurement of commodities. These twin institutions sought to assure farmers of floor price and guaranteed buyer and went a long way to instill confidence amongst farmers. In essence, approach adopted during this period was putting Marketing system in place to incentivise output and manage its distribution through public procurement.

Policy framework employed to obtain Food security was three pronged:

a. subsidy on inputs and output (minimum support price)
b. public storage, procurement and distribution of food grains
c. trade protection measures and regulation of markets (to avert situations of deficit)

Besides advent of Green Revolution (distribution of high yielding varieties), Other measures initiated during this period included establishment of 5 Regional Rural Banks (RRB) in October 1975 and NABARD in 1982 to provide sufficient banking and credit facility for agriculture and other **rural** sectors.

Phase III: Post-Green Revolution Period (1980-91) : In this phase, emphasis was laid on diversification towards high value produce by expanding adoption of technology to other produces such as commercial horticulture. Coconut Development Board and National Horticulture Board were established during this period.

Phase IV: Economic Reforms Period (1991-2015) : In the wake of surplus production of foodgrains, approach was oriented to gaining greater international market access and Liberalisation of agriculture trade. The functioning of markets was sought to be improved. India opened up its economy in 1991 – Industry and service sectors liberalised but not agriculture except a few baby steps.

Model APMC Act 2003 was created to increase private sector participation in marketing and processing.

In this phase, India signed AOA of WTO on 1 January 1995

Phase V (2015 onwards) : One nation, One market, One tax, ICT enabled marketing : The country was Food Secure but there was a problem of plenty. Approach during this period was towards a National unified market

Electronic National Agricultural Market (e-NAM)

Model APML Act 2017 allowing for operation of alternate markets and unified national markets

GST roll out, streamline inter-state trade.

Model contract forming and services Act

Agricultural export policy

Gramin agriculture markets (GrAMs)

Agricultural sector, huge in size and complex in nature, cuts across domains and all socio-economic backdrops, and therefore, the approach to it cannot remain in a narrow prism of a traditional farmers' discipline. The Hon'ble Prime Minister's call of doubling farmers' income has effectively given direction that farming must be treated as an enterprise, and that future agricultural development will have the returns and not just the output from the farms as its prime objective. This requires a multitude of cross-domain considerations in bringing a holistic and long lasting strategy to the agricultural domain.

Opportunities

Rising demand for high value commodities such as cheese, olive oil, apples, pears, wine may be of interest to both the EU and India;

Growth of the organized market for milk and certain milk products is hovering around 20 percent;

EU is the second biggest destination for India's agricultural exports;

India has not attained its full production potential and there is strong domestic demand. Opportunities exist for technology transfer (seed, irrigation practices, retailing, food processing and certification, R&D); and

High demand for knowledge and financial resources to ramp up primary production towards food processing and retail sector.

Challenges

Indian agriculture predominantly rainfed, high probability of exogenous shocks. aberrant weather conditions cause huge Crop damage;

Agriculture subsidies tend to promote both excessive use of water as well as GHG emissions through a number of related channels

Many policy induced inefficiencies : For instance, Power subsidies stimulate both high power consumption and high GHG emissions, causes excessive drawdown of ground water and depletion of water tables.

Strengthening resilience to Climate Change, Adaptation and Mitigation;

Way Forward

Agri-work-force needs to be schooled and skilled to augment their productivity; Then they can move to high-productivity jobs in urban areas; and eventually, share of agri-work-force may come down, say to less than 20%.

Increase land productivity which will help freeing up of scarce land which can be utilised for an alternative use.

When rocket is to be launched, it is to be fired from the bottom. Visualize Indian economy as a rocket comprising of three tiers: agriculture at the bottom, manufacturing in the middle and services sector at the top. If reforms are like launching the rocket, it is to be fired from the bottom and not from the top. This cardinal error of judgment India had been making until 2014 i.e. reforms were introduced in secondary and tertiary sectors of the economy and kept the primary sector i.e. agriculture away from those reforms. In 2020, reforms are being introduced in agriculture sector i.e. rocket is being fired from the bottom. Agriculture is now being put in the right orbit and there is a credible hope that farmers welfare and their incomes will be on higher trajectory of growth.

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4. Agriculture Markets in India

Gold is gold when it is sold. What farmers produce is no less precious than gold, yet their income levels have not augmented commensurately. Clearly something is missing. What is that? All that is required is to ensure just two things namely 'get the prices right' and 'get the markets right'. Just getting the 'prices right' may be a necessary condition but not sufficient. Imagine a situation when farmers get most lucrative prices but half of their marketable surplus remains unsold, they would still be left high and dry.

'Market' and 'marketing' are inter-connected. Market is a place which facilitates exchange of goods and services. When it is in physical form, it is referred to as a market place, and when it is digital in nature, it is market space. On the other hand, marketing system helps to direct and crystallize demand, develop capacity to ensure operational and pricing efficiencies. Marketing efficiency is to be achieved by reducing dispersion between prices paid by consumers and those received by farmers.

Until 1960s, agriculture was largely a subsistent economy; one-third of India's agricultural production was non-monetised. There was a low marketable surpluses, leading to stunted exchange function of marketing.

In Post Green Revolution, non-monetised situation of the 1960s changed. Agriculture markets, policies and institutes developed to facilitate sale of farm produce. Agriculture Markets geared up to play an exchange function – to make Agriculture a profit oriented commercial activity

With a view to improve the functioning of markets and liberalising agriculture trade, the Union Ministry of Agriculture proposed a **Model** Agricultural Produce **Market** Committee **(APMC) Act 2003** on agricultural marketing in consultation with State governments for adoption by the States. It was expected to increase private sector participation in marketing and processing. However, this this did not happen.

The farmers should be able to evacuate the entire surpluses from their farm gates to demand Centres. So far, the focus of marketing has been only on price discovery. At best 45% to 50% of marketable surplus in India get integrated with marketing. Even if we ensure the best prices for this much production, remaining more than half of the marketable surplus still fail to get monetized. We should aim at evacuating all the surpluses of all the commodities from all the corners of the country to demand centres. Here, we are to look beyond APMC and see how to meet the demand in consumption centres or export demand. Else, farmers would continue to suffer from distress sales.

According to one study, Rs 93,000 crores worth of agriculture produce in India was wasted in a year only because farmers were not able to channelize this in the marketing system. If we had good logistics, good warehouses and could identify the demand centres in time, this amount would have gone to farmers hands, thereby their income would have been augmented by that much amount. Due to gaps in the storage and marketing infrastructure, and absence of post-harvest protocols, the country suffers huge post-harvest losses.

Agriculture production system or agriculture supply system has changed over time and the marketing functions as a response system has also changed slowly and steadily. The State is divided into several market areas, each of which is administered by a separate APMCs. This imposes its own marketing regulation. Therefore, reforms in agriculture markets are called for to facilitate farmers to have greater access to markets.

While several states have amended the APMC Act to allow farmers to sell to non-APMC licencees, a central law is being brought in to enable farmers to have the freedom of choice to sell their produce without going through the existing markets administered by APMCs.

The entire focus of agri-reforms upto 2014 was on improving production and productivity. The post-2014 reforms in agriculture is the period of robustness of agri-reforms. The emphasis shifted to Direct Benefit Transfer (DBT) and e-NAM (electronic National Agriculture market). E-NAM sought to integrate mandis and address information asymmetry so as to ensure price realisation by farmers. In the first phase of e-NAM, 585 mandis were covered under it, 415 more mandis have been integrated to e-NAM. There are now 1000 mandis under this platform and consequently volume of trade has also augmented.

The Government has made pioneering efforts towards aggregation and economic inclusion of small and marginal farmers in agribusiness activities by enhancing access to credit and creating strong marketing linkages. Over 10,000 Farmers Produce Organisation (FPOs) have been formed.

The Essential Commodities Act (ECA) 1955, was born in a scarcity economy 65-year ago. This Act came into being at the time of food deficit when it was imperative to have such an act in place. Notwithstanding the fact that this Act is out of sync with the current ground reality of marketed surplus production of food in the Indian agrarian economy, it was allowed to continue to be in vogue against the interests of farmers at large. Only in 2002, EC Act was tinkered with for the first time and merely 14 commodities were taken out of the Act. Now in 2020, it has been defanged and will go a long way in augmenting the farmers income levels.

If the Government enables farmers to have direct marketing system whereby they can connect to ultimate purchaser without routing trough APMCs, farmers would be able to realize full value of their produce. This would be a game anger as it would ensure that exporters, wholesalers start going to the farm gates rather than farmers going to mandis and it would also facilitate capturing value of every grain, every ounce.

Adapting to Model Agricultural Produce and Livestock Marketing (Promotion & Facilitation) Act, 2017 APLM Act 2017 will be a game changer in agricultural marketing. Promotion of direct interface between farmers and processors, exporters, bulk-buyers and end users will reduce the price spread between producers and consumers. This will bring advantage to both the producers and the consumers.

Farmers are now having more information about price trends, demand and now realise better prices of their produce. They are more empowered now than ever before. Farmers Produce Organisations (FPOs) /Farmer Producer Companies (FPCs) play a pivotal role in facilitating marketing. They are promoted to mobilize small and marginal farmers and can be a contracting party if so authorized by the farmers.

Way Ahead

Agriculture marketing need to move from 'farm to fork' to 'fork to farm', implying that production decision should not be independent of demand but demand should emit signals to farmers to what to produce. This will facilitate them calibrating and designing their production in tune with the demand. Only then, farmers as entrepreneurs can benefit from marketing, wastage can be minimised and the value of every grain can be monetized.

There are several post harvesting technology which needs to be adopted. The focus should not only be on production infrastructure but also on post production infrastructure. Robust supply chain is necessary from production to consumption. Rs 100,000 crores allocated for infrastructure recently (May 2020) will go a long way in improving the cause of farmers.

NITI AYOG has identified agriculture as an area where high tech emerging technology, artificial intelligence block chain could be used. The country is committed to digital India and one of its important pillars is agriculture. India has adapted well to the tech in the last few years.

When farmers are enabled to move crops across the borders, they would get the right price. The new law will also free farmers to take their produce to the most lucrative market.

Equally important, the government will create a 'legal framework' to allow farmers to enter into contracts with processors, exporters, aggregators, and large retailers so that farmers have some certainty **over prices they will** receive.

Now, the farmers welfare has been brought to the centre of development agenda. Just as examples, defanging of the Essential Commodities Act (ECA), 1955, enabling farmers to move crops across the borders by bringing in new central law and creating a legal framework for contract farming will empower them to realise the 'prices right'. There is a credible hope that Indian agrarian Society may find renewed global predominance.

- Geographical Indication (GI) is a sign used on products, that have a specific geographical origin and possess qualities or a reputation that are due to that origin.
- to function as a GI, a sign must identify a product as originating in a given place.
- In addition, the qualities, characteristics or reputation of the product should be essentially due to the place of origin.
- Since the qualities depend on the geographical place of production, there is a clear link between the product and its original place of production.
- Agri-entrepreneurs are emerging to fulfil a vital role, to compress lengthy supply chains and provide primary processing services closer to rural communities. Such partnerships can be promoted.

Significance of agricultural marketing:

1. It is aimed at providing remunerative prices to the farmers.
2. It ensures supply of food of required quality at reasonable prices to the consumers.
3. An efficient marketing system minimizes costs and maximizes benefits to all sections of the society.

AGRICULTURE PRODUCE MARKETING COMMITTEES (APMC)

APMC is a statutory market committee constituted by the state government in respect of trade in certified notified agricultural or livestock or horticultural products, under the APMC Act issued by that state government. APMC law states that first sale of agricultural produce can occur only at the mandis of Agricultural Produce Market Committees.

APMC Act was enacted with the following intentions:

1. Providing market-led extension services to the farmers.
2. Ensuring transparency in the pricing systems and transactions taking place in the market area.
3. Ensuring that farmers are not exploited by the money lenders who compel farmers to sell their produce at the farm gate for an extremely low price.
4. Ensuring payment for agricultural produce sold by the farmer on the same day.
5. Promoting agricultural processing activities.

However, **there are some major issues with the functioning of APMCs**:

1. APMCs suffer from **poor infrastructure** like lack of cold-storage and transport facilities. As a result, much of the perishable commodities gets wasted.
2. APMC mandis charge **multiple entry and exit fees** as well as licensing fees.
3. Markets are **over-regulated** leading to a lot of corruption and exploitation of farmers.

4. **Rise of intermediaries** in the APMC mandis who often form cartels, manipulate prices and deprive the farmers of remunerative prices.
5. **Hoarding of agricultural produce** by the APMC middlemen leads to an artificial shortage of food supply in the open market, thereby driving up the food inflation.
6. Under APMC regulation, no exporter or processor can directly buy agricultural produce from the farmers. This **discourages processing and agri-exports**.
7. Since only the state governments can set up APMC market as provided under the legislation, it **prevents the private sector from setting up markets** and investing in marketing infrastructure.
8. APMC office bearers also **lack corporate skills** for vertical integration with food processing industries.

Model APMC Act, 2003

Some of the **salient features of the Model APMC Act, 2003** include:

1. Facilitating contract farming model.
2. Special market for perishables.
3. Allowing farmers and private persons to set up their own markets.
4. Relaxation of licensing norms.
5. Single market fee.
6. APMC revenues to be used for improving market infrastructure.

Model Agricultural Produce and Livestock Marketing (Promotion & Facilitation) Act, 2017

Major provisions of the Draft Model Act are:

1. It specifies a single license for trading within the State and at the National level.
2. Traders will be allowed to sell perishables outside existing mandis.
3. Farmers can directly sell their produce to the bulk buyers.
4. The greatest extent of a market fee is not more than 2% (of sale price) for foodgrains and 1% for fruits and vegetables.
5. Warehouses, private market yards, and cold storages would be permitted to act as regulated markets.
6. All regulatory powers will lie with the office of the director of agricultural marketing in the state, who will also issue licenses to traders and new private players.

INTEGRATED SCHEME FOR AGRICULTURAL MARKETING (ISAM)

The Integrated Scheme for Agricultural Marketing has six sub-schemes namely

i. Agricultural Marketing Infrastructure (AMI),
ii. Marketing Research and Information Network (MRIN),
iii. Strengthening of Agmark Grading Facilities (SAGF),

iv. Training, Research and Consultancy through National Institute of Agricultural Marketing (NIAM),
v. Agri-business Development through Venture Capital Assistance (VCA) Project Development Facility and
vi. National Agriculture Market (e-NAM).

e-NAM (ELECTRONIC NATIONAL AGRICULTURAL MARKETS)

e-NAM is a pan-India electronic trading portal which networks the existing APMC mandis to create a unified national market for agricultural commodities**. Small Farmers Agribusiness Consortium (SFAC)** is the lead agency for implementing e-NAM under the aegis of **Ministry of Agriculture and Farmers' Welfare, Government of India**.

GRAMIN AGRICULTURAL MARKETS (GrAMs)

GrAM is a village level market in India. There are 22,000 such rural agricultural markets which helps farmers in selling their produce locally. Farmers can directly sell from GrAMs instead of transporting their produce to the APMC mandis. These local markets, GrAMs, will be linked with the electronic farmer marketplace, e-NAMs (electronic National Agricultural Markets) to sell their produce nationally.

AGRI-EXPORTS

Since 1991 LPG reforms, India has constantly remained a net exporter of agricultural products. **Rice** has the greatest share in our export basket, followed by oil meals and sugar.

Agricultural exports bring crucial forex earning for India. Also, farmers are able to reap the benefits of higher prices of agricultural products in the international markets, thereby raising their farm incomes. Through export of agricultural commodities, Indian farmers get an opportunity to take part in the global supply chains. Further, exports also promote value addition to agricultural products due to a huge demand of processed foods in the international market. Forward and backward linkages are also created in the agricultural sector.

To tap the huge international market for our agricultural produce, the Commerce Ministry released the **Agri Export Policy, 2018**. Some of the targets to be achieved under the policy are as follows:

1. To double the agricultural exports from $30 billion in 2018 to $60 billion by 2022 and reach $100 billion in the next few years.
2. To diversify our export basket by including items like wild herbs, aromatic oils, confectionary and processed foods, etc.
3. To diversify our export destinations by including more countries in our export list.
4. To boost agricultural value-added exports like jams etc.
5. To focus on branding and marketing of Indian ethnic products in overseas market.
6. Encourage private investment in areas like cold chain storage.

7. To help exporters with Sanitary and Phyto-Sanitary (SPS) issues so that their products are not banned in countries like U.S.A on allegations of not meeting their health safety standards.

Problems facing agricultural marketing in India and its solutions
Some of the problems being faced by the agricultural marketing sector in India in general includes:

1. Warehousing facilities for storage of agricultural produce is inadequate.
2. **Poor transportation facilities** like unusable roads and lack of connectivity makes it difficult to take agriculture produce to the markets.
3. In the absence of proper agricultural markets, most farmers are forced to sell their output to local moneylenders at a much cheaper price.
4. In the **absence of market intelligence**, farmers are unable to assess the correct price of their produce based on the demand-supply equations.
5. APMC mandis face their own set of challenges like poor storage facilities, intermediaries charge their own commissions from farmers, and corruption.
6. There is a complete lack of awareness amongst the farming communities regarding the **commodity trading**.

To solve these above stated problems, government is implementing steps like e-NAM, and contract farming. Government of India also drafted a Model law- Agricultural Produce and Livestock Marketing (Promotion and Facilitating) Act, 2017. Apart from these, **NITI Aayog also recommended certain reform**s like:

1. Take fruits and vegetables out of the APMC Act.
2. Set up markets in the private sector (private mandis) and direct marketing to reduce the dependence of farmers on the intermediaries.
3. Adopt e-trading, single trading license and a single point of levy of market fee.

Government also needs to focus on strengthening the storage and transport infrastructure to reduce the costs associated with agricultural marketing. Information asymmetry needs to be addressed by promoting agricultural marketing research and disseminating market intelligence to the farmers so that they could appropriately price their produce based on the market demands.

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5. Risk Management in Agriculture

Agriculture is an enterprise under an open sky, which is highly uncertain. It is exposed to multiple risks at all stages of its long value-chain - pre-production, production and post-production segments. Cultivation being biological in nature, is vulnerable to several internal and external factors at different stages.

Climate change causes increase in the frequency, intensity and duration of extreme weather events such as droughts, floods, heat waves, hailstorms and cyclones, thereby cause extensive crop damages. Both endogenous and exogenous factors need to be identified, evaluated, negotiated and managed.

Risk typically refers to the probability of an endangering act or event and is closely associated with damage or loss, physical or financial. It arises due to:

- **i.** The uncertainties inherent in weather, yields, global markets and government policies; prices and other factors also impact agriculture, and cause wide swings in farm income;
- **ii.** Risk management involves choosing among alternatives in such a manner as to reduce financial effects that can result from uncertainties
- **iii.** An efficient marketing system backed by a robust agri-logistics, price & demand forecasting and market integration are important components that not only mitigate risks but also build the ability to take certain market risks.

Risks and Farmers' Income

The wide array of risks to the agriculture sector has effect on

- **i.** yield
- **ii.** overall productivity of assets
- **iii.** market access
- **iv.** demand, supply and prices
- **v.** Stability in agri-export-import policy which includes tariff and non-tariff barriers

Each of these impinges on farmers' income.

What could be Strategy to Counter Risk?

Risk mitigation normally requires a strategy on both financial cover and physical front. This includes building resilience and capacity to recover from challenges resulting from *force majeure* events, man-made actions, which could be omissions or commissions. The focus on income security of farmers is taking agriculture into the phase of risk management with a view to neutralising or minimising the impact of risks. Farmers' propensity to take a risk or challenge new frontiers is limited due to resource crunch.

Classification of Risks : Broadly speaking, risks can be classified into 5 buckets:

Cultivation centric (both Pre-production and Production), Agri-logistics centric, Marketing centric, Market predictability centric and Universal impact. Let us identify sources of these risks and mitigation strategy

i. **Cultivation centric Risks**: Besides Weather, other sources of risk of this kind are soil health, input quality. The production being biotic in nature, the range of factors that affect the biological processes of breeding, rearing or cultivation are sources of risk. And its mitigation strategy would be Forecasting, planning, irrigation, insurance.
ii. **Agri-logistics centric Risks:** Inability to directly communicate the output with markets of choice, quality & availability of storage & transport. Mitigation include Aggregation hubs, village level logistics services.
iii. **Marketing centric Risks**: include Inefficient and ineffective market architecture, farmers not empowered to use markets as access platform, market only a transaction point. For mitigation: markets as supply chain component are to be reoriented and reformed.
iv. **Market predictability centric Risks**: Lack of quality and timeliness in periodic demand forecast. Production not linked to market demand. Farmers produce regardless of demand. Sometimes, focus only on *post facto* price information. For mitigation: Market intelligence to drive crop planning so as to enable farmers to calibrate and design their production according to demand.
v. **Universal impact Risks:** Trade policy, tariff and non-tariff barriers, restrictive market rules, undeveloped inter-state trade, procurement limited only to a few crops and regions, production centric rather than income centric public policy, water scarcity, climate change, decreasing per capita arable land, resource extractive and unsustainable production system.

1. **Paradigm Shift**

   Of late, climate change has been causing significant disruptions to ecology in general and its impact has not bypassed agriculture. The major cause of climate change is attributed to green house gas emissions (GHG).

2. As the impact of climate variability on agriculture in different agro-climatic systems has changed, the changes in risk management approaches have shaped the mitigation and the response strategies of farmers and societies.

3. Hydro-meteorological risks such as droughts, floods, heatwaves, hailstorms, and cyclones not only endanger human lives and property, but also have a devastating impact on farmers' livelihood systems. Small, marginal and resource poor farmers, particularly in rain-fed regions do not have inbuilt buffering mechanisms. And they are the ones who are more vulnerable to the severity of extreme climate events.

4. Technology is emerging as a powerful tool to deploy credible forecast, early warning, alerts well in time. It can be gainfully utilised in agriculture across its multiple sub-sectors to be informed in advance, and take appropriate actions that will help in mitigating the risk impact, and secure output and income.
5. Risk management in agriculture ranges from informal mechanism like avoidance of highly risky crops, diversification across crops & sub-sectors, and across income sources to formal mechanisms like agriculture insurance, minimum support price system and futures markets.
6. Even a cursory look at the set of agricultural activities and its business ecosystem will bring forth a sense of the unique set of uncertainties the system faces.
7. Vagaries of Weather and force majeure events are normally beyond control of human intervention. However, its impact can be contained by an improved ability to predict an occurrence and act to repair or negotiate any detrimental impact.
8. On the other hand, the market associated risks faced by farmers can be better managed and possibly be avoided by means of technology, enabling tools and good governance.
9. The entire set of economic endeavours is hinged on the core undertaking of cultivating and producing useful goods. One of the important aspects of risk management, is linked to the ability to forecast inclement weather situations, take steps to minimise the hazard, and insure to offset any damage that occurs.
10. The downside of this is that investments made in the factors of production by a farmer are put at risk and at times are irrecoverable. Weather changes the outcome from farms and is a key factor that makes farming more a matter of chance.
11. A long term, more drastic impact from climate change is a major concern of risk in the agricultural system. The data points available over the last decade demonstrate greater certainty of climate change and associated risks.
12. The changing climate is a major impediment in sustaining agricultural productivity, especially in case of small and marginal farming, where the event of loss of even a single crop can lead to starvation or malnutrition of the family.
13. Given that the risk is a way of life in agricultural system, it needs to be negotiated and managed. Resilience and capacity to face risks needs to be built. The ability to take risks allows various actors in the agri-value system to explore and develop new markets.
14. The risks are both internal and external in nature, affecting the biotic system in the sector and the external services that depend on agricultural produce.
15. Forewarning is forearming and early warning about an inclement weather can minimise its impact. This necessitates sharing of information and knowledge with farmers in advance and on real time basis.
16. Govt. can play a pro-active role in dissemination of credible forecast of demand and prices well before sowing so that farmers can calibrate and design their strategy on **what to produce, how to produce and for whom to produce**.
17. While it is not possible to eliminate risks altogether, it is possible to prepare the farmers to face the probability of the occurrence of such a risk, and enable them to negotiate and manage it appropriately with a view to minimise the negative outcomes.

18. Emerging Technology can be gainfully deployed across agricultural sub-sectors to forecast early warnings and alerts.

19. With the power of technology, it is possible to collate data from dispersed geographies and subject them to big data analytics and draw meaningful forecast that can be shared with the farmers. Here, timeliness of forecast is no less important than the forecast itself.

20. The litmus test of success of emerging technology in mitigating risk lies in its ability to enhance farmers' welfare and bring monetary gains to them.

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6. Transformation of Agriculture

Agriculture has been 'industrialised' by adoption of modern technologies in many developed countries, where Digital technologies are finding increasing use in the agricultural value system, and farmers are progressively becoming more informed.

In emerging economies such as India, the increasing availability of energy and internet connectivity to the large rural landscape, there is tremendous scope to accelerate adoption of High-tech farming.

Digital technologies such as Artificial Intelligence (AI), Big Data Analytics, Blockchain Technology, Internet of Things (IOTs), sensors, logic controlled systems can play a transformational role in modernising agricultural activities and rural India.

Technology has convincingly played its role of 'rescuing ship' in the past when it turned around agri-India to one of net food exporting countries from net food importing country. And there is every reason to belief that the technology will continue to help agriculture economy.

While a section of farmers in India is forward looking and takes advantage of technology and various support services, not all of them do so. Only about one-fourth of farmers in India are reported to had ever been exposed to any kind of demonstarttion and training.

In this connection, Farmer **FIRST** concept needs to be strengthened and up-scaled across the country to focus on empowering farmers and to promote group based technology adoption. Here **FIRST is acronym** for **Farm-Innovation-Resources-Science-Technology**)

The linkage between the research in labs and its use by the farmers needs considerable strengthening. To reach unreached, We need to Make Research – Extension - Farmer - Market continuum more dynamic and interactive.

Appropriate and timely adoption of such technologies can lead to smart farming. Here **Smart means specific, measurable, attainable, relevant, and time-bound.**

Why transformation in agriculture is necessitated? There are 3 main reasons for this which are climate change, **food and nutrition security,** and **Competitiveness augmentation**.

i. **Climate changes** cause increase in frequency, intensity and duration of occurrence of natural disasters such as droughts, floods, cyclones, hailstorms, heatwaves. Such disasters cause extreme agrarian distress and hardship to most farmers. Technology offers solutions to mitigate the problem and future agriculture can benefit from agro-ecological intensification.

There is an urgent need to deepen the understanding and breaking the nexus of drought, land degradation and poverty for improving livelihoods through sustainable intensification of natural resources using high technology led approach.

ii. **Increasing Competitiveness** Technology helps augment productivity, reduce cost of production and make products globally more competitive
The cost of labour is going to be far more expensive in relation to cost of capital in next 10 - 15 years hence there is scope for more automation in agriculture.

With spread of technology, there is a greater emphasis (demand) on trimming of number of working hours. Implicit in this is to reduce drudgery and thereby it will spur the demand for higher level of farm mechanisation.

iii. **Food and Nutrition Security** The transformation in agriculture is necessary not only from perspective of food and nutrition security, but also needed to secure raw material for a vast multitude of industries that depend on agriculture

Given the dominance of marginal and small farm holdings in India, it is imperative to empower and handhold them in adoption of high technology.

They are the ones who get affected more by increasing climate aberrations. Therefore, incentivising such farm holders for the adoption of technologies is called for.

1. Technology exists for agriculture, but the barrier to its adoption lies in taking it to the farm gates. **Farming as a Service (FaaS)** may offer a solution on a **pay-per-use** model. It can help reach out to a larger base of farmers, as capital investments and financial hurdles will be avoided in FaaS.
2. FaaS converts fixed upfront costs into variable ongoing costs for farmers, thus making the techniques more affordable for a majority of small farmers. Pay-per-use service models are one of the solutions to the enduring challenge of raising farm productivity without burdening the farmer with significant capital expenditure.
3. It essentially entails innovative, professional-grade solutions for agricultural and allied services via a subscription, pay-per-use service across three broad categories:

i. Farm Management Solutions, such as precision farming tools, low productivity, lack of farm mechanisation, access to markets and data asymmetry;
ii. encourages product innovations and tools for real-time data capturing and analysis.
iii. information management between farmers, government, financial institutions and advisory bodies
iv. Faas can provide various services, including land preparation, crop harvesting, management, renting of equipment that help production, labour services and utility services, tools for real-time data capturing and analysis, aggregation of farmland and farm produce, and technology for farmers and many more.
v. Market Linkages, connecting farmers with suppliers through digital platforms, of input services as well as consumers of farm produce.
vi. Coordination between all the direct stakeholders (start-ups, investors, governments and corporations) and indirect stakeholders (local entrepreneurs, implement suppliers, agronomists and IT vendors).

For example, data regarding quality of supplies (such as seeds, and fertilisers), soil quality and weather is collected directly through farmers, market agents, government agencies and high-tech equipments like drones and satellites. This data is processed and analysed with technology, big data support. The information is then disseminated via mobile alerts or dashboards; and stakeholders are trained using assimilated data.

Blockchain in Agriculture

Blockchain seeks to help in establishing direct link between farmers and consumers/retailers. It empowers small farmers to organize themselves and get together to reach the market without taking any help from middlemen.

It (Blockchain) gives transparency in supply chain, enabling farmers to get the real price for their produce. With Blockchain, one can expect an efficient supply of products, fair pricing, and improved product tracking.

With blockchain technology, one can put all the information about the entire cycle of agricultural events onto blockchain to enable transparent and trusted source of information for the farmers. In Blockchain the information is highly secure and tamperproof.
Farmers can get instant data related to the seed quality, soil moisture, climate & environment related data, demand and sale price- all at one platform.

Artificial Intelligence (AI) too has a lot of potential to transform the Indian Agriculture Space. With the help of AI, farmers can analyze a variety of things such as weather conditions, water usage or soil conditions collected on real time basis.

Precision farming uses **AI** technology to aid in detecting diseases in plants, pests, and poor plant nutrition on farms and take suitable action accordingly.

To help farmers with the labour shortage, AI agriculture bots can be employed. **AI**-enabled **agriculture bots** help farmers to find more efficient ways to manage their on-farm and off- farm business.

These bots can harvest crops at a higher volume and faster pace than human labours, more precise and by having a round the clock labor force.

Internet of things (**IoT**) is a system which requires no human-to-human or human-to-computer interaction.

There are 5 important ways IoT can improve agriculture:

i. Huge Data collected by smart agriculture sensors can be used to track the state of agri-business in general.
ii. Better control over the internal processes and, as a result, lower production risks. The ability to foresee the output of production allows farmers to plan better distribution and evacuation of production in full. One can make sure that product won't remain unsold.
iii. Cost management and waste reduction.

iv. Increased business efficiency through process automation. By using smart devices, farmers can automate multiple processes across their production cycle, e.g. irrigation, fertilizing, or pest control.
v. Enhanced product quality and volumes. Achieve better control over the production process and maintain higher standards of crop quality and growth capacity through automation.
vi. It is used to determine machine performances and satellite images to look into the health of the crops and harvesting status.

Future R&D approach should be reoriented to address the following:

i. Propagating More crop per drop of water, given water scarcity
ii. Digitization of soil nutrition maps & precision farming
iii. Data capture from field using sensors, weather gauge stations and satellite technologies for weather forecast.
iv. Demand & Price forecasts well ahead of sowing and plantation season
v. The large parts of India's rainfed agricultural systems including the hilly tracts, also deserve to become the core of research and technology innovations

CONCLUSIONS

Technology has no upper bound and adoption of high tech in agriculture is crucial to transform agriculture. In India, increasing availability of energy and internet connectivity to large rural landscape has formidable potential to accelerate adoption of technology in the sector. The high technology can penetrate even in a small holder-dominated agrarian society. IT & ICT be deployed at the multiple touch points along the supply- value chain. On the way, this transformation will get more robust and help expanding linkages with international markets.

However, the transformation should be based on the fulcrum of sustainable technology. Scaling up of transformation of **agriculture by adopting high tech in a mission mode is the way forward to ensure farmers welfare.**

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7. WTO and Agriculture

Imagine a situation when many people are driving fast from different directions without traffic lights at road crossings. Will there not be a chaos? As road need traffic signals for an orderly movement, so does International Trade require predictability and stability in the rules of business? And World Trade Organization (*i.e.* WTO) seeks to provide this.

The long-term objective of the Agreement on Agriculture (AoA) is "to establish **a fair and market-oriented agricultural trading system**". **Its roles include:**

i. operating a global system of trade rules,
ii. acting as a forum for negotiating trade agreements, and
iii. settling trade disputes between its members;

The Uruguay Round of multilateral trade negotiations (1986-1994) resulted in an Agreement establishing the World Trade Organization (WTO), which serves as an umbrella agreement.

It was established on 1 January 1995 with 164 Members and is based in Geneva. It is successor to GATT, but subsumed GATT.

The Scope of WTO agreements covers **goods, services and IPRs.** Annexed to this umbrella agreement are dispute settlement mechanism, the trade policy review mechanism and the **plurilateral** agreements.

The original GATT applied to agricultural trade but it contained a number of loopholes that were exploited by countries, resulting in highly distorted international agricultural trade.

The Agreement on Agriculture (AoA) is an important outcome of the **Uruguay Round** of multilateral trade negotiations. It introduced disciplines in three pillars:

i. market access – *(various trade restrictions confronting imports);*

ii. domestic support – *(subsidies and other programmes);* and

iii. Export **competition** and other government support programmes that subsidize exports.

The **AoA** was intended to provide a framework for the long-term reform of agricultural trade and domestic policies over a period of time. It includes provisions that encourage the use of less trade-distorting agricultural domestic support policies.

Although the obligations for developing countries looked less stringent, the provisions of the **AoA** were framed in such a way that developed countries retained the right to continue to provide high subsidies and use various tariff-related measures which led to a distortion of the global agriculture markets.

The **Doha Ministerial Declaration of November 2001** committed Members to substantial improvements in market access; phasing out of all forms of export subsidies; and substantial reductions in trade-distorting domestic support.

In 2001, agriculture negotiations became a part of the agenda of the Doha Round of trade negotiations. The Doha Round remains unfinished and it is uncertain when or even whether it will be concluded.

Virtually every item of the Doha Round negotiation is considered as part of a whole and indivisible package and cannot be agreed separately. In other words, "nothing is agreed until everything is agreed". Further, all major decisions in the WTO are normally taken by consensus.

An agreement to eliminate agricultural export subsidies was pushed through, during the Tenth Ministerial Conference of the WTO held in Nairobi in December 2015. But other parts of the agriculture negotiating agenda namely, market access and domestic support, remain deadlocked.

Although the AoA was supposed to result in decline in domestic support in agriculture, in fact, the overall value of such support has increased. The agreement obliged developed countries to reduce the AMS (Aggregate Measure of Support). However, only some types of subsidies fall under the AMS. While developed countries reduced their AMS, they also increased their exempted subsidies significantly, thereby offsetting the AMS reduction and resulting in an increase in total domestic support.

Various kinds of subsidies and support are broadly classified in 3 different boxes namely **Green Box, blue box and Amber box.**

Green Box include the amounts spent on Government services such as research, disease control, and infrastructure and food security. ... Since they are permitted in WTO regime, the most developed countries have kept providing **subsidies** to their farmers.

It is important to note that many of the provisions of Green Box support (Annex 2 of the AoA) were formulated to allow developed countries to continue providing subsidies without any limit. To illustrate, the provision allows the US to provide unlimited subsidy through its Food Stamp scheme. On the other hand, developing countries are constrained by their *de minimis* limit in providing support for food security through public stockholding programmes.

Blue Box

Under Blue Box, subsidies are provided to limit production by imposing production quotas or requiring farmers to set aside part of their land.

There is no upper bound on the amounts of such subsidies.

Given the shortage of food production in developing countries, little wonder then that Developing countries have not been able to take recourse to this option. Empirics show that these provisions have been mainly used by the EU and by the US in some years. Thus, the

AoA resulted in a category of domestic support that can be used by the developed countries without any limit.

Amber box (AMS or Aggregate Measure of Support) **subsidies** are those **subsidies** which distort the international trade by making products of a particular country cheaper in comparison to same product in another country.

Examples of such **subsidies** include input **subsidies** such as electricity, seeds, fertilizers, irrigation, minimum support prices etc.

Nearly all domestic support measures considered to distort production and trade (with some exceptions) fall into this **box**

Any domestic support, which is not covered under the categories of Green Box, or the Blue Box, is categorized as **Amber Box** support.

It includes price support measures and all non-exempt direct payments.

It consists of two parts—product-specific subsidies and non-product specific subsidies

Imbalances in the Export Subsidies Pillar

The imbalance and asymmetries in the provisions on export subsidies in the AoA are huge. Countries that were providing high export subsidies in the reference period of 1986-1988, acquired the legitimacy to continue to provide export subsidies in future. On the other hand, most of the developing countries did not provide export subsidies during the base period. As a result, they are unable to provide significant export subsidies.

Tariff Bindings

Quantitative restrictions on agricultural imports were put in place in India mainly due to Balance of Payment (BOP) reasons. Following the Uruguay Round, India only had to bind its tariffs and schedule the bound rates and she submitted binding tariffs ranging from 15 percent upto 300 percent.

Notwithstanding high bound tariffs, the actual applied rates of tariffs on most agricultural products are quite low. For about 90 percent of tariff lines, the applied rates are up to 50 percent only in case of India.

An important part of India's agricultural support regime is its Minimum Support Price (MSP) for public procurement operations of staple food items. Under the *de minimis* provisions, as a developing country, India is entitled to provide 10% of the total value of production of a basic agricultural product as product specific support and 10% of the value of total agricultural production as non-product specific support.

There is an Optical Illusion in Product Specific Subsidy for MSP operations. These look large but are not so because current Procurement Prices are compared with the Prices in the reference period 1986-88 i.e. with those prices that prevailed over 30 years ago, and without any adjustment for inflation. In essence, there is a statistical flaw in the methodology in which such subsidies are worked out.

At the end of the round, higher the MSP, higher is the subsidy component, other things being equal.

Emerging Scenario in AoA

The WTO is facing multiple challenges. Given the slow progress under the Doha Round and the lack of consensus on how to move forward, WTO's negotiating arm is almost paralysed. During 2008 and 2013, the Doha negotiations remained in a state of dormancy.
'Peace Clause' permits developing countries to procure foodstuffs for public stockholding programmes, even if the domestic support that is attributable to the procurement exceeds the ceilings of subsidies specified in the AoA.
The term **'peace clause'** has been a cause of disquiet ever since India flagged the issue of domestic food security in the WTO negotiations.
At India's insistence, the WTO Members agreed to put in place an interim mechanism for the issue of public stockholding in relation to support provided for traditional staple food crops in pursuance of public stock holding programmes for food security purposes.

What lies ahead

From 2015 onwards, developed countries and some developing countries no longer endorse the Doha Round…. and instead started negotiations on Electronic commerce, Investment Facilitation, Trade and Gender, Trade and MSME

WTO is cast in the mould of interest of developed world and its rules have curtailed the policy space for developing countries, but some developing countries like India have gained in agriculture sector as it is net food exporting country. US is attempting to marginalize WTO and is likely to aggressively seek bilateral deals. it Is not merely a short-term disruption.

Developed countries have virtually resorted to '**Phenomenon of kicking away the ladder'**, meaning thereby that once a country has attained the summit of greatness, she *kicks away the ladder* by which she has climbed up, in order to deprive others of the means of climbing up after her. In the aftermath of Covind-19 with a paradigm shift towards Atamnirbhar, there will be an increasing tendency to reduce dependency on other Nations for key food supplies. Rules of the game of WTO are likely to undergo irreversible changes. **World is changing rapidly and WTO is smart enough to keep pace with emerging changes.**

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8. Fertiliser Policy and Direct Benefit Transfer (DBT)

Fertilizers are crucial productivity augmenting inputs. To meet the challenge of rising demands of food, feed and fibre with limited land and water resources, it is imperative to augment land productivity and one way to do this is to make fertilisers easily accessible to farmers.

With this end in view, fertiliser sector in the country is subsidised. Foodgrains production has increased to more than comfortable level. And much of this increase came in the post-green revolution period when high-yielding variety seeds (HYV seeds), along with irrigation and fertiliser usage, picked up pace. Chemical fertilisers have played an important role in increasing grain production.

Keeping in mind the importance of agriculture in any sizable country to feed its people, the form of subsidisation has often varied, with most developed countries having moved from **price support to income support** (with the notable exception of Japan and South Korea). However, India extends support to agriculture primarily through price policy, be it for output or inputs.

It is in this context that one should see fertiliser pricing and subsidy issues in India. The fertiliser subsidy is one of three 'big ticket' items in the basket of total subsidies in the country. It commands over one-fourth of total subsidies in 2020-21.

Crops require right mix of three fertilisers *viz*. nitrogen, phosphorus, and potassium or NPK.

i. **Nitrogen or simply Urea :** helps in plant growth and development,
ii. **Phosphorus or P** : accelerates blooming and also helps plants to withstand stress; and
iii. **potassium** or K helps the process of photo synthesis and is essential to plant growth.

The functions of these nutrients are complementary and do not substitute one another. Balanced fertilisation of soil would mean application of all of these nutrients in the soil in the correct proportion, using appropriate methods and in a timely fashion so that the soil remains healthy and fertile to ensure increasing grain production on a sustainable basis.

The requirement of three different nutrients varies from crop to crop, soil to soil. An all-India recommended doses of N:P:K is in the ratio of 4:2:1, on an average. That means if 10 kgs of **potassium is required to be used in a certain crop in a given piece of holding**, 20 kgs of Phosphorus **and 40 kgs of urea is to be applied. However, ground reality show that over 60 kgs of urea as against the requirement of 40 kgs is** applied. Clearly, consumption ratio has been highly skewed in favour of urea.

Imbalanced use of N, P and K has led to loss of fertility in the soil over a period of time, which affects efficiency of fertilizer use and crop productivity.

A question arises as Why has skewedness in application of fertiliser crept in? To deepen the understanding of this, let us have a look at pricing policy of fertilisers.

Urea, the only controlled fertilizer, is sold at statutory notified uniform sale price and decontrolled Phosphatic and Potassic fertilizers are sold at an indicative maximum retail prices (MRPs).

While the prices of urea are fixed and subsidies levels float, it is the other way round in case of P and K. The current price of urea at Rs.5360/tonne, just as an example, is low due to subsidy in relation to about 3 to 5 times that of other two nutrients.

Favourable pricing policy of urea in comparison to those of other two nutrients has driven farmers to overuse urea. Thus, pricing policy impinges on balanced use of fertilisers.

Of late, consumption ratio of urea in relation to other two nutrients has ebbed somewhat. It may also be noted that measures like neem coating of urea has reduced its diversion to non-agriculture purposes which makes it appear as if its actual consumption of this fertiliser in the agriculture sector has declined.

In any case, over use of urea has double whammy and needs to be fixed on priority. First, it extracts higher than necessary domestic resource costs (DRCs) in production of urea in excess of 'real' demand and secondly it damages soil which impinges on productivity.

A more fundamental question arises as to why fertiliser subsidy was introduced in the first place?

In the backdrop of food scarcity in the country, price concession on inputs such as fertilizer was offered to increase their adoption and thereby augmentation of production

Food security vision of India was driving the agriculture sector

High yielding variety (HYV) needed intensive use of inputs like water & fertilizers;

To promote use of fertilisers, its prices were subsidised

Since the agricultural markets were not efficient enough to discover remunerative prices of the output, they had to be offered price support in the form of procurements at MSP

This chain comprising several links came to be built on heavy subsidies at each stage.

It turned out to be a typical case of acquiring a cat to keep off the rat, which then necessitated acquisition of a cow to produce milk for the cat reared at home and so on.

Due to subsidised prices of urea in India, there have been cases of its smuggling to neighbouring countries and diversion to industrial use, besides other mis-uses of subsidies.

To improve efficiency and cost effectiveness of the subsidy, the Government of India has introduced DBT system for fertilizer subsidy payments under which 100% subsidy on various fertilizer grades is released to the fertilizer companies on the basis of actual sales made by the retailers to the beneficiaries.

Let us have a look at Current form of DBT

Sale of all subsidised fertilizers to farmers is now made through Point of Sale (PoS) devices installed at each retailer shop. Aadhaar enabled Fertilizer Distribution system (AeFDS) has been introduced. The farmers will continue to purchase Urea at statutory subsidised prices, as earlier.

the fertiliser companies which used to receive subsidy on receipt of fertilisers at the district level, now get subsidy after sale to farmers by the retailers through PoS machines upon biometric authentication. The point of sale (PoS) devices have been installed at each retailer shop.

This DBT approach enables to track movement at the lowest formation of the administrative set up and ensures availability of fertilises to farmers.

However, this version of DBT does not help much in terms of balanced use of various types of fertilisers nor does it empowers farmers with the FoC.

What is the Way Ahead?

Cash transfer directly (DBT) to the farmer in lieu of fertilizers at subsidised prices will benefit them as they would be empowered to choose the fertilizer combination best suited to their soil texture without the influence of the distorted price relatives of NPK.

This will also give farmers the freedom of choice to produce any crop that do not require urea. Currently, the extant instrument of pricing policy of subsidies nudge farmers to produce more of crops like wheat and rice which require use of urea. In contrast, Farmers are disinclined to produce more of pulses, just as an example, as this crop require fertilisers other than urea which are relatively expensive. Consequently, production-mix continue to remain out of sync with demand. This entails its own opportunity cost.

The solution lies in freeing up subsidising fertiliser as an input and give cash directly to farmers on per hectare basis in lieu of this subsidy.

A pre-requisite for real DBT is **Digitisation of land records.** Without setting the land records right, it will not be possible to transfer the subsidy to beneficiaries. Though the process of digitisation of land records was launched in August 2008 but has not gathered momentum in many states. This calls for states' to take up the issue immediately.

According to an estimate made by this Professor, if cash amount @ Rs. 5250/hectare is transferred in lieu of fertilizers subsidy to semi-medium farmers (middle group) and to others in a graded system, higher amount to farmers with smaller holdings and lesser to large farmers, it would not lead to any additional net outgo from the exchequer, over and above the current level of fertilisers subsidies is extended.

The proposed DBT would empower farmers to choose the fertilizer combination best suited to crop they choose to grow, the soil texture without the influence of the distorted price relatives of NPK.

It will be a 'win win' situation if the Government walks the last mile in fully implementing DBT in case of fertilizers subsidy.

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9. Agriculture Pricing Policy

Remunerative and assured prices are essential for increasing agricultural production and productivity along with better markets to farmers.

With a view to evolve a balanced and integrated price structure and resolving the claims of competing crops on limited resources to the perspective of the overall needs of the economy, the Minimum Support Prices (MSP) of certain agricultural crops are fixed for every season in India.

For a particular crop and for a given crop season, it is the same across all geographies of the country.

The Government seeks to fix prices that would fulfil obligations of justice to the consumers and yet provide a surplus and incentive to all efficient farmers.

In a sense, a 'double bind' situation prevails in fixing the prices where the consumers' capacity to pay prices for food and Government's capacity to incentivise farmers for food production beyond a certain point are both limited.

Crops Coverage under MSP

MSP is fixed on the recommendations of the Commission for Agricultural Costs and Prices (CACP), an attached office of the Ministry of Agriculture and Farmers Welfare and announced before the sowing season. As of now, the **MSP is offered on 23 commodities**:

- 7 cereals (paddy, wheat, maize, sorghum, pearl millet, barley, and ragi)
- 5 pulses (gram, tur, moong, urad, and lentil)
- 7 oilseeds (groundnut, rapeseed-mustard, soyabean, sesame, sunflower, safflower and nigerseed)
- 4 commercial crops (copra, sugarcane, cotton, and raw jute)

For sugarcane, the mechanism is a bit different. It requires the sugar mill companies to pay a **Fair and Remunerative Price (FRP)** fixed by the government whereas for other crops, government itself procures at MSP. FRP varies according to the recovery of sucrose percentage. As recovery rates vary from state to state, so do effective FRP. This is in contrast to fixed MSPs across states in case of other 22 crops.

The question arises as to Why Fixing Prices in the first place?

- For Large and growing population, food security to be provided;
- Two successive droughts in 1965-66 &1966-67;
- With a view to boost production, the Government of India introduced MSP Scheme as an incentive to the farmers.
- Demand of more food with limited land and water resources
- Inadequate foreign exchange constrained FoC to import key staples from global markets
- 'Ship to mouth': Heavy dependence on foreign aid (PL-480) often had political strings attached;

Institutions Created

- It was recognized that mere announcement of MSPs without back up of market intervention in the form of procurements would not be effective.
- To advise & implement a remunerative price policy, ‘twins’ {APC (CACP) & FCI} conceived & borne in Jan, 1965.
- Besides setting up of Food Corporation of India (FCI) in 1965 to primarily undertake procurement operations of foodgrains, the Government decided in 1985 to entrust NAFED with the responsibility of price support for pulses and oilseeds.

What are the Determinants of MSP?

There are 7 main parameters which determine MSPs

i. demand and supply situation of main product and by-products
ii. cost of production;
iii. price trends in the market, both domestic and international,
iv. inter-crop price parity,
v. terms of trade between agriculture and non-agriculture sector,
vi. likely impact of MSP on consumers, producers and overall economy
vii. rational utilization of natural resources such as land, water resources

In addition to these 7 parameters, another factor has been added recently in determining MSP. And that is a minimum of 50 percent as the margin over cost of production is allowed.

Cost of production is an important factor but certainly not the only factor that determines MSP. Thus, MSP is NOT a cost plus pricing exercise, as many a times, some farmers’ organizations and even agriculture Scientists (mis)construe.

The Commission uses crop-wise, State-wise cost data to estimate all-India weighted average cost of production.

In view of wide variations in resource endowments in terms of agro-climatic conditions, soil and productivity profiles, input usage, and cost of production, differential prices at regional levels were advocated by some experts.

In fact, the system of differential support prices for different states had been tried out from 1965 to 1972, but it was later given up due to likely build-up of inefficient structure in production and in pattern of resource use.

A uniform support price across the country has been in vogue since then. This is justified on the ground that it alone could lead to comparatively efficient use of resources.

In addition to this, a uniform price policy encourages crop specialization and optimum use of agrarian crop land and other resources on the basis of comparative advantage.

Various kinds of costs:

There are a number of cost concepts but most widely used are 3 types. These are A2, A2 +FL and C2:

i. Cost A_2: All actual expenses in cash and kind incurred in production + rent paid for leased-in-land
ii. Cost A_2 +FL: Cost A2 + imputed value of family labour
iii. Cost C_2: Cost A_2 +FL + imputed interest on value of owned capital assets (excluding land) + imputed rental value of owned land (net of land revenue)

It follows that cost C2 is always more than cost A2+FL which in turn is more than A2.

Whose Cost to be considered?

Crop-wise, State-wise cost of production (CoP) are considered while formulating price policy. The question arises as to Whose Cost to be considered?

One of the criteria for deciding the level of MSPs is cost of production (CoP). Needless to say, CoP varies a great deal from region to region, state to state, district to district and farm to farm. If these costs were to be normally distributed, about 50 percent of farmers would be those whose CoP would be less than weighted average Cost but there would also be other 50 percent whose costs would be much higher than this weighted average.

In case of cotton, for instance, 51 percent of production is covered at weighted average C2 Cost. It is, therefore, expected that other 49 percent of cotton growers would often question the reliability of cost estimates. This is a characteristic of any data set and this *per se* is not a reflection on the quality of data. Such a state of affairs would always emerge in all crops, *albeit* with varying magnitudes.

Weighted Average Cost Vs. Bulk line Cost

Though there is no mechanical linkage of MSP with any cost, yet it is important to think of an alternative to the weighted average CoP *viz*. bulk line cost in pricing policy.

In that event, definition of bulk line may have to be crop specific for a specified period depending upon abundance or scarcity of the individual commodity and comparative advantage of growing that crop.

For instance, all-India weighted average cost of production of groundnut cover only 41 percent of production (Gujarat only) which indicate prevalence of high level of efficiency gaps in the production system. This low share of 41 percent has to be ramped up by addressing inefficiency issue through technology transfer and replication of best farming practices on a wider scale across states.

Structure of Comprehensive Cost of Cultivation

i. Labour cost, the largest single factor of production, is followed by land cost, capital cost, other inputs, fertiliser (5%).
ii. Though fertilisers play a crucial role in productivity, it constitutes just 5% in total cost of production of crops. In case prices of fertilisers increase by 20%, just as an example, its impact on total cost of production will be 1%.
iii. Many a times farmers organisations make out a case to increase MSP at least as much as increase in prices of fertilisers. They often demand 20% increase in MSP if there is surge in fertilisers prices by 20%, just as an example. As a Policy maker, one may be conscious of the fallacy in this argument.

Inverse Relationship- Productivity & Cost

- Other things being constant, Empirics show that higher productivity reduces the Real cost of production and have the potential to drive up farm income
Why Productivity is critical?

  - Volume of international trade, other things being equal, is greatly influenced by prices
  - One way to reduce real prices of commodities is to increase their total factor productivity (TFP) much faster than demand
  - land productivity, a partial component of TFP, impacts cost of production

Imperatives of Productivity Augmentation

- Increases potential for Agri-exports to expand
- can trigger rural demand and drive the economy to a higher growth trajectory.
- Precious natural resource (land) can be 'freed up' for the same level of production,
- Equivalently, higher production can be achieved by the same land and other inputs

Drivers of Productivity include

❖ Fertilizers
❖ Irrigation
❖ Seed
❖ Management Practices &
❖ Extension Services
❖ Fertilizers are generally consumed where there is assured irrigation.
❖ Irrigation and fertilizers' roles are overlapping in raising returns to farmers, where both represent adoption of technology. Empirics show a high correlation between Fertiliser consumption and gross returns.
❖ Fertiliser used is more in irrigated lands, implicitly subsidy goes to irrigation tract.
❖ More emphasis needs to be laid on investment in irrigation and rational utilisation of fertilizers.

Returns Augmenting

- Of late, demand from various stakeholders to increase MSP of various agricultural commodities has been intensifying and the main ground on the basis of which this demand is justified is monotonously increasing cost of production year after year.
- MSP is recommended not solely on the basis of costs, though it is duly factored in while recommending price policy.
- The answer to contain increasing cost of production lies in enhancing yield levels as, an inverse relationship exists between real cost of production and yield rates.

A way forward is to create structures to enable adoption of modern technology by small and marginal farms who constitute over 85% of holdings. That will lead to productivity augmentation, reduce the cost of production, enhance competitiveness both in domestic and international markets and ultimately lead to farmers' welfare.

Food Corporation of India (FCI)/NAFED **procurement at MSP** is not geographically well spread. Farmers in remote and tribal areas are unable to bring their produce to the procurement centres. A **robust network of procurement agencies** should be available for the farmers from all geographies of the countries.

Government introduced decentralized procurement. **States which adopted decentralized procurement (DCP) include**: A&N Islands, Karnataka, Kerala, Odisha, Tamil Nadu, Andhra Pradesh, Telangana, Maharashtra, and Jharkhand (for **rice**); Gujarat, Punjab, and Rajasthan (for **wheat**); Bihar, Chhattisgarh, Madhya Pradesh, Uttarakhand, and West Bengal (for **rice/wheat**).

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10. Sustainability Concerns in Agriculture

Sustainable agriculture is the successful management of resources for agriculture to satisfy the changing human needs, while maintaining or enhancing the quality of environment, improving the social and economic conditions of the farmers, agri-labour and local communities.

It also includes safeguarding the health and welfare of farmers and conserving renewable natural resources.

The practice of sustainable agriculture is important as it accelerates the productivity, efficiency and employment, and reduces the practices which adversely affect quality of soil, water resources and other natural resources.

The accelerated use of natural resources, the degradation of the land resource base with accompanying impacts on biodiversity, and also effects of climate change are all posing a challenge to the survival and welfare of the people.

Natural resources need to be managed in a holistic manner as there are direct linkages among the various components.

The intensification of ecological agriculture is now required more than ever before as it has the potential to sustainably feed the growing population by bringing **evergreen revolution based on 'sustainable thinking'.**

Given that India is going to be most populous nation on this planet by 2027, and its demand for food, feed, fiber is going to accelerate rapidly with rising per capita income, both land and water are going to be under tremendous pressure.

It is increasingly realized that water is going to be a bigger constraint in Indian agriculture than even land.

Despite about 83 per cent of supplies of water towards agriculture, more than half (52%) of Indian agriculture is still rainfed, resulting in underachievement of potential productivity and profitability.

This situation emerges primarily due to highly skewed distribution of irrigation water amongst crops. More than 60 per cent of water used for agriculture purposes is utilised for irrigating two water guzzler crops, rice and sugarcane, having a share of just 24 per cent in gross cropped area.
This skewed water allocation and inefficient irrigation practices like flood irrigation are raising flags regarding sustainability of water use in Indian agriculture.

1. **Climate Change**

   has gained significant international attention over the past few decades due to concerns of deleterious long-term impacts on agriculture, water supply and human welfare.

   It can impact agriculture in various ways. For example, :

   i. Soil getting drier, reduced productivity
   ii. reduced supply of water for Irrigation,
   iii. Increased ranges and populations of **Pests**:
   iv. Increased diseases and heat stress on **Livestock**

Strategies for sustainability will include:

I. **Conservation Agriculture and Residue Management**
II. **Integrated Farming System (IFS)**
III. **Watershed Management:**
IV. **Good Agricultural Practices**
V. **Rainfed agriculture**

I. Conservation Agriculture and Residue Management

i. The conservation agriculture, which is advocated as an alternative to the conventional production system, has been adopted by the Food and Agriculture Organization (FAO) of the United Nations as a lead model for improving sustainability.
ii. The primary focus of developing and promoting CA (Conservation Agriculture) practices in India has been the development and adoption of zero tillage cum fertilizer drill for sowing crops.
iii. Concerns about burning of crop residues and its increasing costs of management, declining water tables and increasing environmental problems are the major factors forcing a look at alternative technologies.
iv. Development and promotion of appropriate farm machinery are needed to facilitate collection, volume reduction, transportation and application of crop residues, and sowing of the succeeding crop.

Conservation Agriculture leads to variety of benefits that include:

i. Economic benefits that improve production efficiency.
ii. Agronomic benefits that improve soil productivity
iii. Environmental and social benefits that protect the soil and make agriculture more sustainable.

II. Integrated Farming System (IFS)

i. IFS is a positive interaction of two or more components of different nature such as crops, livestock, fishery, trees within the farm to enhance profitability in a sustainable and environmentally friendly way.
ii. A judicious mix of two or more of these farm enterprises with advanced agronomic management tools may compliment the farm income together with help in recycling the farm residues.

iii. The selection of enterprises must be based on the cardinal principles of minimizing the competition and maximizing the complementarity between the enterprises.
iv. IFS are a practical way forward for agriculture that will benefit the society, not just those who practise it.
v. It is a dynamic concept which must have the flexibility to be relevant on any farm, in any country, and it must be receptive to change and technological advances.
vi. IFS are an entire complex of development, management and allocation of resources as well as decisions and activities, within an operational farm unit, or combinations of units.
vii. The existing trade pattern is unsustainable and needs to be corrected by reforming the trade policies in favour of import of water intensive crops and export of water efficient crop.

III. **Watershed Management:** The purpose of Watershed management is to sustain and enhance watershed functions that affect the plant, animal, and human communities within the watershed boundary. It helps creating jobs and incomes for the welfare of the watershed community.

IV. Good Agricultural Practice

The Food and Agricultural Organization (FAO) of the United Nations uses **Good Agricultural Practice (GAP)** as a collection of principles to apply for on-farm production and post-production processes.

There are four 'pillars' of GAP:

i. **environmental sustainability**
ii. **economic viability**
iii. **social acceptability**
iv. **food safety & quality.** This results in safe and healthy food and non-food agricultural products,
v. These must be included in most private and public sector standards.
vi. The concept of GAPs has evolved in recent years in the context of a rapidly changing and globalizing food economy,
vii. and as a result of the concerns and commitments of a wide range of stakeholders about food security, food safety and quality, and the environmental sustainability of agriculture.
viii. A broadly accepted approach using GAP principles, generic indicators and practices will help guide national policies, actions and preparation of strategies.
ix. This will ensure that all stakeholders benefit from the application of GAP in the food chain.
x. **Some of key elements of GAP include**: • Prevention of problems before they occur • Risk assessment • Commitment to food safety at all levels • Communication through the production chain • Mandatory employee education program at the operational level • Field and equipment sanitation • Integrated pest management • Oversight and enforcement

xi. Growers who adopt good agricultural practices can go through a voluntary auditing process to verify that they follow the standards. Successful completion of an audit results in GAP-certification for the grower.

V. **Rainfed agriculture**

1. is important for the country's economy and food security since it contributes to about 40 per cent of the total foodgrains production, supports two-thirds of livestock and 40 per cent of human population.

i. The state of rainfed agriculture is precarious and the problems associated with it are multifarious such as scarcity of water, low cropping intensity, high cost of cultivation, poor adoption of modern technology, uncertainty in output.
ii. Solar panels may be set up on farmers' field as a third crop. The "Solar crop" can additionally act as a source of income insurance to farmers. **The Solar Pump Irrigators' Cooperative Enterprise (SPICE) in** Gujarat, just as an example, is worthwhile model that can be followed and scaled up.
iii. **A holistic development including rainfed agriculture is warranted for improving sustainability**. A site specific Real Time Contingency Planning (RTCP) needs to be developed to ensure better performance of crops during seasonal drought and extreme events.

VI. **To conclude,** sustainable agriculture is critical in ensuring viability and consistent growth in both farm production and income. For this, a holistic approach is required.
VII. **The implementation of Good Agricultural Practices would contribute to Sustainable Agriculture and Rural Development (SARD), will help** creating new market opportunities for farmers and exporters in developing countries.
VIII. Given the challenges emerging from climate change, which hint towards greater frequency, intensity and duration of droughts, floods, heatwaves, and hailstorms, India must focus not only on augmenting its utilizable water resources but more importantly on using scarce water resources more efficiently.
IX. The first and foremost thing in that direction is to measure and monitor water-productivity of agriculture.
X. The inequity in irrigation water allocation among crops, with more than 60 per cent of it being utilised for cultivation of two water guzzler crops – sugarcane and paddy, add to distress in agriculture water use. Competing demands of water from rapid urbanization and industrialization cannot be met unless agriculture makes a paradigm shift in water use.
XI. A production system can be considered as truly **sustainable**, only when it balances the economic interests with the ecological demands.

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Agriculture

Chapter 2

Short Answers

CSM-05: Compiled by Prof. Ashok Vishandass

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This chapter contains:

- Doubling of Farmers' Income
- Agricultural Inputs - Labour
- Agricultural Inputs – Land
- Agricultural Inputs- Fertilizers
- Agricultural Inputs- Irrigation
- Agricultural Inputs- Credit
- Agricultural Subsidies
- Public Distribution System
- Income support to farmers
- Introduction to Agriculture

Contents

1. Doubling of Farmers' Income

The Doubling Farmers' Income (DFI) Committee recognises agriculture as a value led enterprise and suggests empowering farmers with "improved market linkages" and enabling "self-sustainable models" as the basis for continued income growth for farmers. This builds the basic strategy direction for four primary concerns: optimal monetisation of farmers' produce, sustainability of production, improved resource use efficiency and re-strengthening of extension and knowledge based services.

The Committee identifies and focuses on seven major sources of growth (Volume II), operating within and outside the agriculture sector. These are,

• Improvement in crop productivity. • Improvement in livestock productivity. • Resource use efficiency or saving in cost of production. • Increase in cropping intensity. • Diversification towards high value crops. • Improvement in real prices received by farmers. • Shift from farm to non-farm occupations.

The DFI Committee tables the "growth targets" for doubling farmer's real income while improving the ratio between farm and non-farm income from 60:40 as of now, to 70:30 by 2022.

Ensuring food security by increasing agriculture output has been the cornerstone of agricultural development policy in India. This policy objective has been broadly accomplished. Implicit in the strategy was an underlying assumption that benefits of increased production and productivity would have a trickle-down effect on farmers' welfare in terms of their income levels. However, the policy intent has not been fully realized and the farmers' incomes have not risen as expected.

India can ill-afford to continue with tonnage-centric agri-policy i.e. emphasis on increasing production which may not necessarily increase total income of farmers. The disparities in income levels between agriculture and non-agriculture sectors are huge. The **Hon'ble Prime Minister of India made a statement on 28 February 2015 at Bareilly on Doubling Farmers' Income by the year 2022"**. Accordingly, we need to Shift from Green Revolution to Income Revolution for farmers. This is doable if we focus on six broad measures. These are:

1. **Creating an enabling policy framework**
2. **Intensification of farming, diversification to high value agriculture**
3. **Reforms in Agri-Marketing and agri-logistics**
4. **Stable Agricultural trade policy**
5. **Transfer of Technology : Labs to Land**
6. **Agriculture Insurance to cover risks**

Let me now elaborate each of these measures.

1.1 Creating an enabling policy framework

Under this, following measures are recommended:

i. Land is inelastic, yet activities can add income elasticity. For instance, enable farmers to be producer of solar energy (*urjadata*) and let them play a significant role in the country's ambition to be one of the frontrunners in the International Solar Alliance for clean energy.
ii. There is need to encourage the right and optimal kind of **rural industrialisation that captures more value from the produce** and **generates jobs** through near-farm or on-farm activities.
iii. The cost of labour (i.e. wage rates) is going to outstrip the cost of capital in near future and therefore human labour is going to be an issue. The solution lies in promoting farm mechanization, Custom Hiring Centres 'on peruse basis' like **'Uberisation'**
iv. 'Skilling' of agri-labour to enable them to command higher wages and nudge them to move to other sectors of the economy which will help augmenting their income levels.
v. Primary value addition can be encouraged at village level on a cottage scale.
vi. Inherent policy biases in the existing policy framework need to be addressed to make it more balanced.
vii. ensure conservation of scarce resources like water and electricity and achieve 'per drop-more crop'
viii. Help farmers to move towards green and sustainable agricultural practices.

1.2. Intensification of farming, diversification to high value agriculture

i. Empirics have shown that emphasis on increasing production and productivity may not necessarily augment farmers' welfare and their total income. Land, the principle asset of the farmer has direct bearing on the production and associated income to individual farmers.
ii. The average size of operational holdings ebbed from 1.84 hectare in 1980-81 to 1.08 hectare in 2015-16 and this trend is likely to continue in the near future. The dominance of marginal and small farm holdings in India has increased considerably by 10 percentage points to 85.0 percent during the corresponding period.
iii. **I**t is important to have a hard look at **crop geometry** to capture more value from available land. Land is an important factor of production and needs to be used more judiciously. Rice, wheat and corn together command 42% of land under crop cultivation and account for 19% of the value whereas horticulture occupies 12% of land and gives 24% of value. Therefore, there is a case to release surplus land under cereals for high value commodities.
iv. Against this backdrop, we need to enhance farmers' income through appropriate intensification and diversification strategies. The focus is to be laid on ways in which the farmers' incomes can be increased through allied activities like dairy, poultry, fisheries and food processing.

v. The critical inter-linkages between size of holdings, propensity to adopt technology, credit, farm mechanisation, diversification to high value crops and income levels be established.

1.3. Reforms in Agri-Marketing and agri-logistics

Agriculture production should move from '**plate to plough'**, implying that production decision should be demand driven. Crops should be cultivated based on the food habits of people and those which are highly demanded, rather than being independent of demand. It should emit signals to farmers as to **what to produce, how to produce and for whom to produce**. This calls for a policy indulgence to nudge farmers not to cultivate the same crops *en masse*, else it leads to **the 'Cobweb Syndrome'** which follows a particular pattern. Let me briefly touch upon this syndrome:

i. When price of a commodity surge, farmers produce more of that crop next season and price falls down due to excessive supply.
ii. Farmers change crop, the supply reduces next season, and the seesaw cycle repeats.
iii. The price signal *is **ex-post*** (after sales), and the farmer's reaction is ***ex-post facto*** (after the fact has relevance).
iv. For the famers, the temporal increase in price of a crop is a false signal to sow more of that particular crop in the next season.
v. This lag effect between price signal and sowing patterns is an acute failure of the marketing system.
vi. This fluctuation is a result of unguided, action and reaction.
vii. As a result, future growth is stunted, while price and supply balance to reach a steady state.

Therefore, Marketing system is to be made efficient by providing a price signal that is ***ex-ante.*** Under this policy, farmers should be enabled to cultivate crops according to demand, as per experts' findings, to make agriculture profitable. For instance, palm oil cultivation in coastal areas be promoted as India is deficient and imports large quantities of this commodity. India can consider designing 'One village one competitive product' (OVOP) as a business to gain sales revenue. Such a model is in vogue in countries like Japan, Thailand.

Due to gaps in the storage and marketing infrastructure, poor handling practices, lack of proper storage infrastructure and absence of post-harvest protocols, the country suffers huge post-harvest losses. Therefore, reforms are needed in storage and agri-logistics including integrated cold chain, warehousing and food processing;

1.4. Stable Agricultural trade policy

i. Trade Policy for agriculture should aim to facilitate and promote ease of doing business, rather than be restrictive and disruptive to business planning. Trade regime, export promotion and credit policies that affect agricultural trade including export and import of agricultural produce, have tended to have an inadequate focus on the interest of farmers.

ii. A cogent agricultural trade policy ought to be rooted in the long term[1] food and nutritional security concerns of the country alongwith promoting farmers connection with the global markets.
iii. However, the instrument of international agri-trade is often used to control prices in the domestic market, in reaction to short term supply bottlenecks. This tends to negatively impact farmers' incomes.
iv. We need to focus on putting in place a neat, and cogent blueprint of agri-export policy to avoid abrupt restrictions on exports of agri-commodities
v. Since short term view of trade policy compounds the existing risks and uncertainties for farmers, a stable trade regime be designed to maintain a long term view to help farmers build market relationships at the global level.

1.5. Transfer of Technology: Labs to Land

i. The linkage between the research in our labs and its use by the farmers needs considerable strengthening. While a section of farmers is forward looking and takes advantage of various support services such as soil health cards, kisan credit cards, soil testing labs and kisan call centres, not all of them do so.

ii. Development of suitable extension programmes is inevitable to improve farmers' incomes. Agricultural Universities should guide farmers on 'what', 'when' and 'how' of farming, depending upon local conditions.
iii. Additionally, integrated farming system models for small-holders in different agro-climatic conditions needs to be popularized through Krishi Vigyan Kendras (KVKs) and State agricultural universities on a massive scale. Emerging technologies, AI, IOT and Blockchain are adopted under the agriculture sector.

1.6. Agriculture insurance

i. Agriculture is like an industry under open sky where the vagaries of the weather leave the farmers vulnerable and affect their incomes. Along with the perils of natural calamities such as floods and droughts, global warming and climate change are additional challenges being faced by the agriculture sector.
ii. The extreme heat waves and lowered water tables compounds the vulnerability. While the launching of the flagship insurance scheme, PMFBY is a step in the right direction, the low insurance coverage due to a variety of reasons such as affordability of premium, delay in settlement of insurance claims to farmers is a cause of concern and signals the necessity of appropriate changes.

To recapitulate, When agriculture policy framework is reoriented alongwith other measures as outlined, it will lead to higher levels of income of farmers through monetisation of their high value produce, better price realisation, congenial trade policy environment and covering

[1] A long term usually takes 3 years view as in case of Foreign Trade Policy announced by the Department of Commerce

farmers against risk. Doubling of farmer’s income is a dream envisioned with eyes wide open and it will be surely accomplished.

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2. Agricultural Inputs - Labour

2.1. Labour

As per the Agriculture Labour Enquiry Committee, agricultural laborers are those who derive their major income by working on the farms of others for a wage. An agricultural labourer has no right of lease or contract and has no risk in the cultivation of land. He merely works on another person's land for a wage.

The agricultural laborers are: (i) engaged in agricultural or allied activities, (ii) work for a wage in cash or kind, (iii) work full time or part-time, whole year or part of a year.

2.2. Problems faced by agricultural labour in India are:

Marginalization of agricultural workers: While the share of agriculture and allied activities in our country's GDP at factor cost has been constantly decreasing from 55.3% in 1950-51 to 14.0% in 2011-12 (at 2004-05 prices), the workforce in agriculture has increased from 97.2 million in 1951 to around 228 million in 2011-12. This in turn has led to the problem of disguised unemployment as the number of workers engaged in agriculture is far more than what is required.

Labour productivity: The number of workers engaged in agriculture is far more than what is required because industrial growth has been insignificant compared to the population growth and has been unable to absorb the surplus labour. This has led to the problem of **disguised unemployment** and labour productivity has declined. In India, the labor productivity growth rate for the agriculture and allied sector in the fiscal year 2019 was found to be 6% which was the least productive year compared to the last six fiscal years.

Wages and Income: Agricultural wages and family incomes are very low in India.

Employment and Working Conditions: Agricultural workers have to face problems like unemployment and underemployment. Due to the seasonal nature of agriculture, for a major part of the year, agricultural workers have to remain unemployed as there is no work on the farms and alternative sources of employment are not present.

Indebtedness: Due to the paucity of institutional loans in the rural areas, farmers have to rely on the local moneylenders who often lend money at exorbitant interest rates. This pushes farmers into the vicious cycle of debt. Indebtedness has become a major reason for the recent rise in farmer suicides.

Low wages for women workers employed in agriculture: Female workers are generally forced to work harder in the fields and are paid less than their male counterparts.

Menace of child labor: The incidence of child labor is very high in the agriculture sector as not only are they easily available but can also be employed at low wages.

2.3. Feminization of agriculture

Feminization of agriculture refers to the increasing number of female workers in the agriculture sector. **Economic survey 2017-18** says that with growing rural to urban migration by men, there is 'feminization' of the agriculture sector, with an increasing number of women in multiple roles as cultivators, entrepreneurs and laborers.

As per the Food and Agricultural Organization (FAO), women's contribution to Indian agriculture is about 32%. According to Census 2011, out of the total female main workers, 55% were agricultural laborers and 24% were cultivators.

There are several **positive impacts of feminization of agriculture** like:

1. As per FAO, if women had the same access to productive resources as men, they could increase yields on their farms by 20-30%.
2. Research worldwide suggests that women with access to secure land, formal credit, and access to market have a greater propensity in making investments in improving harvest, increasing productivity, and improving household food security and nutrition.
3. Women can propel the country towards second Green Revolution, and they can change the landscape of development if they get opportunities and facilities.
4. As per Oxfam India, women are responsible for 60-80% of food and 90% of dairy production, respectively.

2.4. Challenges faced by women in agriculture:

1. As per Census 2011, only 12.8% of the operational landholdings were owned by women, which reflect gender disparity in ownership of landholdings in agriculture.
2. Lack of ownership of land does not allow women farmers to approach banks for institutional loans as banks usually consider land as collateral.
3. Work by women farmers, in crop cultivation, livestock management or at home, often goes unnoticed.
4. Female farmers are generally excluded from **modern contract-farming arrangements** because they lack secure control over land, family labor, and other resources to guarantee delivery of a reliable flow of produce.
5. With the ongoing innovation in agriculture and the introduction of new technology to automate specific manual labor, women may lose their jobs because they are often responsible for the manual duties.
6. Women farmers in India often face gender discrimination.
7. Lack of skills and insufficient training of women farmers hampers their productivity.
8. Women farmers are poorly represented in the society as well as farmer organizations.

9. When compared to men, women generally have less access to resources and modern inputs (seeds, fertilizers) to make farming more productive.

2.5. Government measures to encourage women's role in agriculture:

1. The government is earmarking at least 30% of the budget allocation for women beneficiaries in all ongoing schemes and development activities.
2. The government is also giving preference to women under various policies such as organic farming, self-employment scheme, Pradhan Mantri Kaushal Vikas Yojana, etc.
3. 15th October of every year has been declared as Women Farmer's Day.
4. Provisions of issuing Kisan Credit Card to women have been made.
5. The focus is on connecting women self-help groups (SHGs) to micro-credit through capacity-building activities and to provide information and ensuring their representation in different decision-making bodies.

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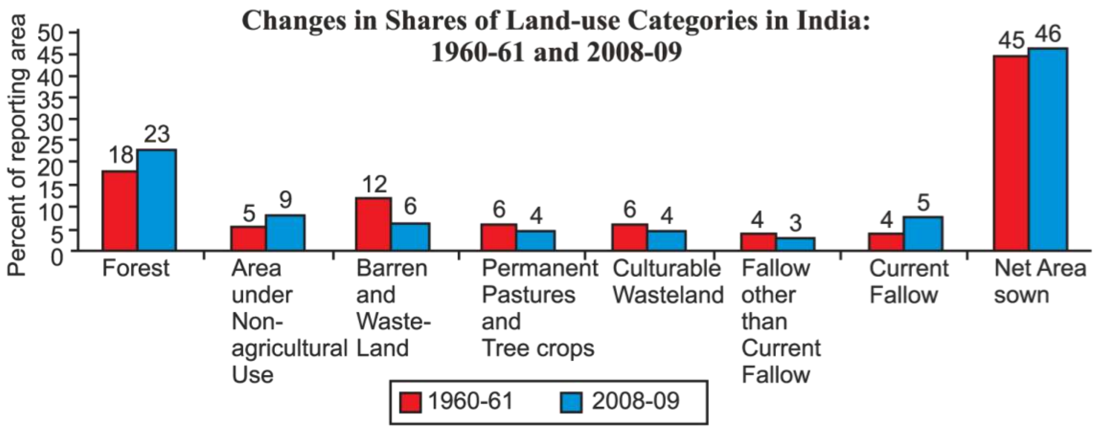
3. Agricultural Inputs – Land

Agriculture is pure land-based activity. The quality and size of land have a direct bearing on the productivity of agriculture. Aside from its value as a productive factor, land ownership also has a social value and serves as a security for credit, natural hazards, or life contingencies, and also adds to the social status. Thus, lack of access to land is directly correlated with the incidence of poverty in rural areas.

3.1. Land use in India

Land revenue records mention different land-use categories- forests, land put to non-agricultural uses, barren and wastelands, area under permanent pastures and grazing lands, area under miscellaneous tree crops and groves (not included in net sown area), culturable wasteland, current fallow, fallow other than current fallow and net sown area.



3.2. National land records modernization programme (NLRMP-2008)

The National Land Records Modernization Programme (NLRMP), launched by the Department of Land Resources under Rural Development Ministry in August 2008, aimed to modernize management of land records, minimize scope of land/property disputes, keep track of land ceilings, enhance transparency in the land records maintenance system and facilitate moving eventually towards guaranteed conclusive titles to immovable properties in the country.

3.3. Major Components of the NLRMP Programme includes:

1. Computerization of all land records.
2. Digitization of maps and integration of textual and spatial data.

3. Survey/re-survey and updation of all survey and settlement records including creation of original cadastral records wherever necessary.
4. Computerization of registration and its integration with the land records maintenance system.
5. Development of core Geospatial Information System (GIS) and capacity building.

3.4. Model Agriculture Land Leasing Act, 2016

NITI Aayog came up with the act having the following main features:

1. Legalize land leasing to promote agricultural efficiency, equity and power reduction. This will also help in the much needed productivity improvement in agriculture as well as occupational mobility of the people and rapid rural change.
2. This is very important step for land reforms through which needs of landlord as well as lease holder have been taken care.
3. Through this Act, the landlord can legally lease the land with mutual consent for agriculture and allied activities. In this Act, it has been taken care that in any circumstances, the leased holders' claim on land will not be valid.
4. Lease holder can receive institutional loan, insurance and disaster relief so that he may invest more and more in agriculture.
5. It allows automatic resumption of land after the agreed lease period without requiring any minimum area of land to be left with the tenant even after the termination of tenancy, as laws of some states require.
6. It incentivise tenants to make investments in land improvement and also entitle them to get back the unused value of investment at the time of termination of tenancy.
7. In order to resolve the dispute between the landlord and lease holder, the provision of "Special Land Tribunal" has been made in the civil court.

3.5. Agricultural Inputs – Seeds

The Seeds Act, 1966 provides for the legislative framework for regulation of quality seeds sold in the country. In order to encourage the exports of seeds in the interests of farmers, the procedure for export of seeds have been simplified. Seeds of various crops have been placed under **Open General License (OGL)** except the seeds of wild varieties, germ plasms, breeder seeds and onion seeds which are in restricted list under the Export and Import Policy 2002-07.

Agricultural yield (amount of crop produced in a given acre of land) depends greatly on seed quality. For best yield, hybrid seeds must be replaced every year, and non-hybrid must be replaced every three years. However, **seed replacement in India is less than optimum.**

Therefore, in order to encourage the seed sector, government has approved **100% FDI in seed development**. Other measures which can be taken to promote the seed sector include steps like strengthening the regulatory mechanism, providing intellectual property rights (IPR) protection to new research and development in this sector, establishing a robust third-party quality certification system for seeds and incentivising private sector in the form of bankable schemes.

3.6. National seed policy, 2002

National Seed Policy, 2002 was launched to provide intellectual property protection to new varieties, usher this sector into planned development, protect the interests of farmers and encourage conservation of agro biodiversity.

The policy had **following thrust areas**:

1. Varietal development and plant varieties protection
2. Seed production
3. Quality assurance
4. Seed distribution and marketing
5. Infrastructure facilities
6. Transgenic plant varieties
7. Import of seeds and planting materials
8. Export of seeds
9. Protection of domestic seeds

3.7. Draft seed bill, 2019

Key provisions of the draft seed bill are as follows:

1. It provides for the formation of **Seed Committee** that will be responsible for the effective implementation of its provisions.
2. All varieties of seeds for sale have to be registered and are required to meet certain prescribed minimum standards.
3. **Licensing norms** have been revised. Now, there will be a differentiation between the seed producer, seed processor and seed dealer for the purpose of licensing.
4. Currently, a large percentage of seed is sold under a self-certification programme called “Truthfully Labelled (TL)” seeds. The **certification process has been kept voluntary**.
5. The bill empowers government to **fix the prices of selected varieties** in case of ‘emergent’ situations like seed shortage, monopolistic pricing, profiteering etc.

3.8. Protection of plant varieties and farmers’ rights (PPV&FR) ACT, 2001

The aim of the act is the establishment of an effective system for the protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants.

The act establishes **Protection of Plant Varieties and Farmers' Rights Authority under the Ministry of Agriculture and Farmers Welfare**. It also establishes **Plant Varieties Protection Appellate Tribunal (PVPAT)** which shall dispose of the appeal within one year and whose decisions can be challenged in the High Court.

Rights under the PPV&FR Act are as follows:

1. **Breeders' rights**: Breeders (seed producers) will have exclusive right to produce, sell, market, distribute, import or export the protected variety.
2. **Researchers' rights**: Researcher can use any of the registered variety under the act for conducting an experiment or research. However, repeated use needs prior permission of the registered breeder.
3. **Farmers' rights**: A farmer can save, use, sow, re-sow, exchange, share or sell his farm produce including seed of a variety protected under the PPV&FR Act, 2001. However, the farmer shall not be entitled to sell branded seed of a variety protected under the PPV&FR Act, 2001. There is also a provision for compensation to the farmers for non-performance of variety. The farmer

3.9. Seed bank/seed vault

The core objective of a seed bank is to make available seeds for contingent situations, develop infrastructure for seed storage and to preserve the genetic diversity.

3.10. Seed Village

As per the Seed Policy 2002, '**The Seed Village Scheme**' will be promoted to facilitate production and timely availability of seeds of desired crops/varieties at the local level. Groups of farmers in a village are given training to produce seeds of various crops so that they can fulfil seed demand of their own and neighbouring villages.

3.11. Green revolution and seeds

Green Revolution refers to large increase in food production with the help of **High Yielding Varieties (HYV) of hybrid seeds**. MS Swaminathan was the man behind the revolution. It strengthened agricultural research and technology that helped to increase agricultural productivity in the developing nations.

The first phase of the Green Revolution was started in mid-1960 and ended in the mid-1970. Two semi- dwarf wheat varieties of Mexican origin, were released for cultivation in irrigated areas. These varieties resulted in high yields and brought about a wheat revolution in India.

In this time phase, the application of HYV seeds were limited to states like Punjab, Tamil Nadu, Andhra Pradesh etc. and mainly benefitted wheat production. The second phase of the Green Revolution was started in 1970 and ended in 1980. The HYV seeds got a nationwide extension and most of the crops were benefitted.

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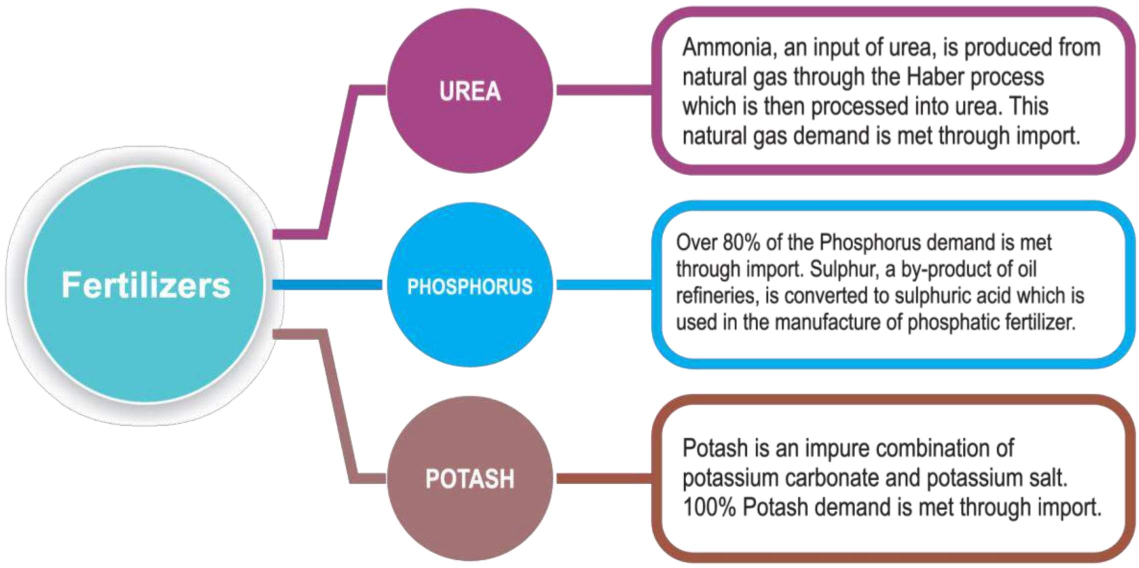
4. Agricultural Inputs – Fertilizers

Fertilizers can be classified into three categories namely- **Primary, Secondary and Micronutrients**. Primary fertilizers are further classified into nitrogenous (urea), phosphatic (di-ammonium phosphate (DAP)) and potassic (muriate of potash (MOP)) fertilizers. Secondary fertilizers include calcium, magnesium and sulphur while micronutrients include iron, zinc etc.



4.1. Indian Fertilizer Industry

1. India is the second largest consumer of urea fertilizers after China and also ranks second in the production of nitrogenous fertilizers.
2. Fertilizer industry is one of the eight core industries.
3. Fertilizer subsidy burden remains high, and India spent nearly Rs 80,000 crore on fertilizer subsidy in 2018.
4. In India, the NPK ratio stands at 6.7:2.4:1 as against an ideal ratio of 4:2:1, showing a skewed trend towards urea consumption.

4.2. General issues with the fertilizer sector in India

1. Fertilizer consumption in India is **highly skewed towards urea** due to growing price difference between urea and other fertilizers.
2. **Overuse of fertilizer** has negative impact on the environment. For e.g., excessive use of nitrogenous fertilizers can increase the acidity of the soil and leaching of nitrate into the ground water can also take place.

3. **Urea import is canalised**, meaning that the importers of urea needs to channelize it through the public sector. This causes inefficiencies like delays in imports which leads to unavailability of fertilizers around planting seasons when the need is most crucial.
4. **Black marketing** of urea is rampant, which puts small farmers at a disadvantage due to higher costs.
5. Urea subsidy also suffers from **leakages** and around 36% of the subsidy is lost through leakage to the industry or smuggled across borders.
6. **Delays in subsidy release** puts strain on the fertilizer companies and makes them unsustainable.
7. The fertilizer sector suffers from **over-regulation**. As the government controls the price of urea, fertilizer companies have no incentive to lower the cost of production, thus leading to production inefficiency.

4.3. Nutrient Based Subsidy (NBS)

NBS is a Central Sector Scheme started by **Ministry of Chemical and Fertilizers** in 2010. Under the scheme, subsidy is given to fertilizer company based on the weight of different nutrients (Nitrogen, Phosphorus, Potassium and Potash) contained in the fertilizer. Apart from this, fertilizers fortified with secondary and micronutrients are given additional subsidy.

NBS scheme is used to determine the Phosphorus and Potassium (P&K) subsidy, which in turn is based on factors like exchange rate, international and domestic prices of P&K fertilizers, inventory level etc. It is to be noted that **Urea has been kept out of the NBS scheme** and a separate Urea subsidy is provided by the government.

NBS scheme was brought in to increase the consumption of P&K fertilizers and check the overuse of urea, thus ensuring balanced fertilization. The scheme was also aimed at increasing the agricultural productivity, supporting indigenous fertilizer industry and reducing the fertilizer subsidy burden.

UREA SUBSIDY

Urea subsidy is a Central Sector Scheme of the **Department of Fertilizers**. The **New Urea Policy-2015 (NUP-2015)** has been notified by the Department of Fertilizers, extended till 2019-20, with the objective of maximizing indigenous urea production, promoting energy efficiency in urea production and rationalizing subsidy burden on the government. It is applicable to the existing 25 gas based units.

Urea is the **only controlled fertilizer** and is sold at statutorily notified sale price. On the other hand, P&K fertilizers are decontrolled and is sold at indicative MRPs.

NEEM COATED UREA

Ministry of Chemicals and Fertilizers made it mandatory for fertilizer companies to neem coat the urea before selling it. **Neem coated urea provides the following benefits**:

1. Neem coating **slows down the rate of dissolution** of urea in the soil, helping plants gain more nutrients based on their needs. This in turn improves yield of produce.
2. Neem coating also **reduces pest attacks** as neem is a natural insecticide.
3. Neem coating will **prevent diversion of heavily subsidized urea** towards non-agricultural purposes like chemicals industry and other uses such as making adulterated milk.
4. Collection of neem seeds for making neem coated urea will also help **generate employment in rural areas**.

SOIL HEALTH CARD

Soil health card is a Core Scheme launched in 2015 by the Department of Agriculture, Cooperation and Farmers Welfare. The Scheme assists State Governments to issue soil health cards to all farmers in the country. A farmer's land is tested and he is given updated soil health card every two years. The scheme also envisages setting up soil testing labs.

Soil health card provides information to the farmers regarding the nutrient status of their soil. It recommends appropriate dosage of nutrients to be applied for improving soil health and its fertility. The card also advises on which type of crops and irrigation methods will suit his farm depending on his soil health.

4.4. Agricultural Inputs – Pesticides

Pesticides are substances used to control pests. The term pesticide includes all of the following: herbicides, insecticides, fungicides, etc.

India is the fourth largest producer of pesticide in the world but our per hectare pesticide consumption is far less than the developed countries. Pesticides in India are regulated under the Insecticides Act, 1968 and Insecticide Rules, 1971. Around 290 pesticides are registered in India with the Directorate of Plant Protection, Quarantine and Storage which is an attached office under the Agriculture Ministry.

Insecticides Act, 1968 regulates the import, manufacture, sale, transport, distribution and use of insecticides and pesticides in order to prevent risk to human beings and animals.

A **Central Insecticides Board** was established under Section 4 of the Act and it works under the administrative jurisdiction of the Ministry of Agriculture and Farmers' Welfare. The role of the board is to advise governments on matters related to the administration of the Act.

Several issues related with pesticide usage in India:

1. Instances of **acute toxicity of farmers** due to pesticides are common. Exposure to pesticides can cause a broad range of nervous system symptoms like headache, fatigue etc.
2. Chronic toxicity of pesticides is a big **health threat for consumers**. Pesticides move up the food chain through the process of biomagnification and ultimately reach humans impacting their health. In 2014, the National Crime Records Bureau (NCRB) recorded 7365 cases of pesticide poisoning, out of which 5915 died.
3. Continuous use of pesticides has negatively impacted the **soil health** and reduced agricultural productivity.
4. While agriculture is a state subject, production, education and research are governed under the Insecticides Act, 1968 which is a central act. This often leads to **regulatory hurdles** and center-state conflict.
5. Other issues include black marketing, rampant illegal usage of banned pesticides etc.

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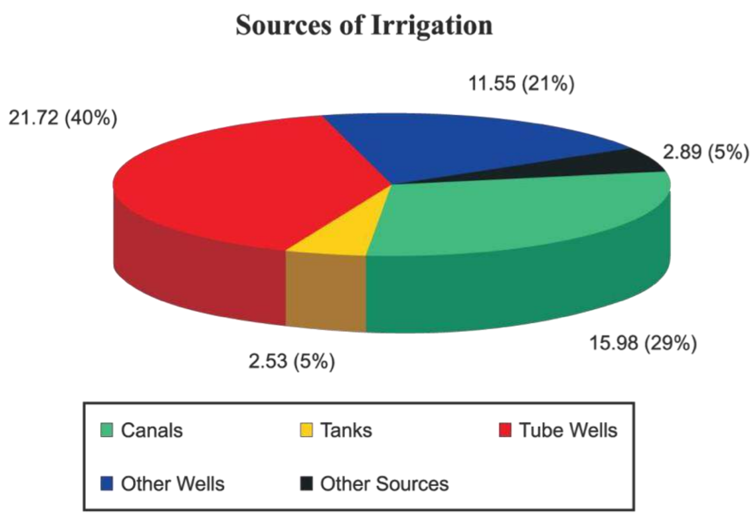
5. Agricultural Inputs – Irrigation

Irrigation is the process of applying water to the crops artificially to fulfill their water requirements. Nutrients may also be provided to the crops through irrigation. The various sources of water for irrigation are wells, ponds, lakes, canals, tube-wells and even dams. There are efficient means of irrigation as well like sprinkler irrigation and drip irrigation.



Irrigation is important for agriculture in the following ways:

1. It helps in increasing agricultural productivity and food production which is crucial to meet the food security.
2. It helps counter the spatial and temporal variations in rainfall as well as its uncertainty, irregularity, unreliability and erratic nature.
3. Irrigation maintains moisture in the soil and improves soil health.
4. Irrigation is a must for water intensive crops like sugarcane and jute.
5. Introduction of high yield varieties like Genetically Modified (GM) crops requires high amounts of water which can be supplied through irrigation.

While irrigation is needed to increase agricultural productivity and meet the rising food security needs of the growing population, it is a matter of concern that about 60% of the total cropped area is still dependent on rain. **Irrigation sector in India faces a number of problems** that needs attention like:

1. In most of the irrigation projects, there have been considerable delays in project completion.

2. Irrigation being a state subject, development of water resource is planned individually by states taking into account their own requirements. However, nearly all major rivers are inter-state which often leads to inter-state water disputes.
3. Inadequate on-farm and off-farm infrastructures and poor maintenance leads to poor irrigation efficiency.
4. Regional disparities are also visible in irrigation infrastructure development.
5. Introduction of irrigation has also led to the issue of water logging and salinity in states.
6. Huge investment is required in operating and maintaining irrigation networks, causing financial strain on the governments.
7. Decline in water due to overexploitation of water has affected our irrigation capacity.

Steps taken by the government:

PRADHAN MANTRI KRISHI SINCHAYEE YOJANA (PMKSY)

PMKSY is a national mission under the Ministry of Agriculture & Farmers' Welfare to improve farm productivity and better utilization of the resources in the country. The scheme has been approved with an outlay of 50,000 crore for the period of 5 years (2015-16 to 2019-20). Major objectives of the scheme are:

1. Convergence of investment in irrigation at field level.
2. Expand cultivable area under irrigation.
3. Improve on-farm water use efficiency to reduce wastage of water.
4. Enhance the adoption of being precise in irrigation and other water saving technologies (more crop per drop).

PRADHAN MANTRI KISAN URJA SURAKSHA EVAM UTTHAAN MAHAABHIYAN (PM KUSUM)

PM KUSUM scheme has been launched recently by **Ministry of New and Renewable Energy (MNRE)**. The scheme aims to provide energy security along with financial and water security to farmers. It will encourage farmers to generate solar power in their farms. The target is to add decentralized solar power capacity of 25,750 MW by 2022. Components of KUSUM scheme are:

1. **Component A**: 10,000 MW of decentralized ground mounted grid connected renewable power plants.
2. **Component B**: Installation of 2 million standalone solar pumps.
3. **Component C**: Solarization of 1.5 million grid connected solar powered agricultural pumps.

ATAL BHUJAL YOJANA

Atal Bhujal has been launched by the **Ministry of Jal Shakti**. It is a Central Sector Scheme to improve ground water management through community participation. Seven states are covered under the scheme- Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh. It is being implemented (starting 2020) over a period of 5 years with 50% support from **World Bank**.

To address the challenges, **following irrigation management measures** are required:

1. Building proper infrastructure like canals for adequate and regular water supply.
2. A proper drainage system needs to be put in place for addressing the issue of water logging and salinity in major irrigation commands.
3. Irrigation efficiency needs to be improved through steps like Micro-irrigation.
4. Improving water productivity through steps like: (i) water should be priced at a level enough to motivate farmers to save water, (ii) energy subsidy for pumping water should be abandoned, (iii) biological water-saving measures, engineering solutions, agronomic and soil manipulation should be collectively explored.
5. Water intensive crops should be cultivated in areas with abundant ground water availability. In areas with ground water shortage, drought resistant crops like maize should be grown.

Agricultural Inputs – Farm Mechanization

Farm mechanization refers to the use various power sources and improved farm tools and equipment, with a view to reduce drudgery of the human beings and draught animals, enhance the cropping intensity, precision in metering and placement of inputs and timelines of efficiency of utilization of various crop inputs (seeds, chemical, fertilizer, irrigation, water, etc.) and reduce the losses at different stages of crop production. The end objective of farm mechanization is to enhance the overall productivity and production with the lowest cost of production.

While farm mechanization is an important input to boost agricultural production and productivity, **it is faced with several challenges** like:

1. There is **low overall mechanization** in India compared to countries like USA, China and Brazil. Major reasons being **economies of operation** due to small land holdings, access to power, credit cost and procedures, uninsured markets and low awareness.
2. Small-marginal farmers **lack financial resources** to own or hire farm machinery.
3. Considering India’s soil and climatic diversity, customized machinery suited to Indian requirements is needed. However, there is **limited Research & Development (R&D)** in the agriculture mechanization sector.
4. **Regional disparities** are visible with Northern India having higher levels of mechanization compared to other regions.

Government initiatives for farm mechanization

1. **Sub-mission on Agricultural Mechanization**: Sub-mission on agricultural mechanization was launched in April 2014 to promote inclusive growth of farm mechanization to enhance productivity. Under the scheme, individual farmers are provided subsidy for the procurement of farm machinery.
2. **In-situ crop residue management**: Special scheme was created for in-situ management of crop residues in the states of Punjab, Haryana, UP and NCT of Delhi. Machines and equipment for in-situ crop residue management are provided with 50 per cent subsidy to the individual farmers and 80 per cent subsidy for establishment of Custom Hiring Centers.
3. **Agriculture Infrastructure Fund**: Government announced a Rs. 1 lakh crore Agri Infrastructure Fund for farm-gate infrastructure for farmers. Accordingly, Central Sector Scheme of Financing Facility under Agriculture Infrastructure Fund was approved by the Cabinet.

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6. Agricultural Inputs – Credit

Timely and adequate availability of finance is a prerequisite for the growth of any sector and agriculture is no exception.

Agri-finance is an essential component of agriculture as:

1. Finance is required to invest in agricultural inputs like seeds, fertilizers, machinery etc.
2. Agricultural finance is also needed for agricultural marketing, post-harvest storage and transport of produce, meeting the risks like damage due to pests, diseases and issues like low rainfall etc.
3. Institutional credit prevents farmers from falling into the clutches of money lenders who often lends at exorbitant interest rates and pushes farmers into debt traps.
4. Having money at disposal also provides a sense of psychological relief to the farmers as they are capable of meeting any unforeseen circumstances like crop losses, natural calamities etc.

To ensure timely availability of credit to the farmers, **government has taken the following steps**:

1. RBI's **Priority Sector Lending norms** stipulate 18% lending target for the agriculture sector.
2. **Nationalization of banks** in India has put them under government control and ensured that banks provide lending to the agricultural sector.
3. **Differential banks** like Regional Rural Banks (RRBs) provide lending to the agricultural sector at concessional rates.
4. Government has initiated **Kisan Credit Card (KCC) Scheme** and interest subvention scheme for providing cheap credit to the farmers.
5. NABARD started a pilot project **SHG-Bank Linkage Programme** in 1992 which also involves disbursal of agricultural credit.
6. **Joint Liability Groups (JLG) Scheme** was initiated by NABARD in 2006 to enhance credit flow to share-croppers/tenant farmers who do not have land rights.

6.1. Agricultural Inputs – Insurance

India is having one of the largest agriculture dependent population in the world. Since it is a high-risk profession as farmers have to depend on rain and general weather conditions to grow their crops, government needs a prudent agricultural insurance policy to protect the farmers against such uncertainties.

Need of agricultural insurance in India:

1. Farmers have traditionally relied on weather conditions to grow their crops. Hence, there is a need to protect them from agriculture variability which often results from uncertain weather conditions.
2. Agricultural crops also witness high price fluctuations, and this necessitates insurance against income failure.

6.2. Pradhan Mantri Fasal Bima Yojana (PMFBY)

Farmers to be covered: All farmers growing notified crops in a notified area during the season who have insurable interest in the crop are eligible. To address the demand of farmers, the scheme has been made voluntary for all farmers from Kharif 2020.

Risks covered under the scheme:

1. Local natural calamities like landslides and hailstorms.
2. Calamities leading to loss of yield like floods, dry spell, droughts, etc. Pest infestation is also covered.
3. Post-harvest losses are also covered.

Units of insurance: The scheme shall be implemented on an ‘Area Approach Basis’ i.e., defined areas for each notified crop for widespread calamities with the assumption that all the insured farmers, in a Unit of Insurance, to be defined as “Notified Area” for a crop, face similar risk exposures, incur to a extent, identical cost of production per hectare, earn comparable farm income per hectare, and experience similar extent of crop loss due to the operation of an insured peril, in the notified area.

Role of states: States/UTs have been given flexibility to choose their scale of finance for any district crop combination. They have also been given option to run the scheme with the selection of additional risk covers. However, if a state fails to release the requisite premium subsidy to insurance companies on time, they will have to face penalty and will not be allowed to run the scheme in subsequent seasons.

While the government is taking steps to promote agricultural insurance, **the sector still faces many challenges** like:

1. **Penetration of agricultural insurance** is still low. A nation-wide crop insurance data by the National Institute of Securities Market or NISM (2014) shows that only 6.7% of the farmers are covered under crop insurance.

2. **Level of awareness** about crop insurance is very low.
3. The low usage indicates that farmers either do not find crop insurance useful or are denied access to insurance.

4. Other issues include delay in distribution of compensation, inadequacy of compensation compared to the costs and inadequate funds allocated to finance the insurance schemes.

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7. Agricultural Subsidies

An agricultural subsidy is a government incentive paid to agribusinesses, agricultural organizations and farms to supplement their income, manage the supply of agricultural commodities, and influence the cost and supply of such commodities.

Agricultural subsidy acts as an incentive to promote agricultural development in India. It helps stimulate agricultural production and attain self-sufficiency. Further, subsidies also contribute to better cropping pattern, employment and income of beneficiaries.

There are **different types of agricultural subsidies** being provided in India:

Explicit Input Subsidies: They are payments made to the farmers to meet a part of the cost input. For e.g., subsidy on improved or high yielding variety seeds, fertilizers, and plant protection chemicals for certain crops.

Implicit Input Subsidies: They are hidden in nature. In the implicit input subsidies, prices of inputs are administratively determined, and priced low compared to their economical cost.

Output Subsidies: This type of subsidy is provided in order to encourage the output of a particular product by partially offsetting the production cost or losses. The objective of this subsidy is to expand production of a particular product more so that the market would promote but without raising the final price to customers.

Food Subsidies: The difference between the per quintal economic cost and the per quintal Central Issue Price (CIP) gives the quantum of food subsidy. Food subsidy comprises of subsidy provided to Food Corporation of India (FCI) for procurement and distribution of wheat and rice and for maintaining the strategic reserves of foodgrains and subsidy provided to states or undertaking decentralized procurement.

As per the Economic Survey 2020, food subsidy incurred by the government has risen substantially over the years from about 0.6 lakh crore in 2009-10 to about 1.7 lakh crore in 2018- 19.

7.1. Agricultural subsidies can also be categorized on the basis of Mode of Payment:

Direct Subsidies: Direct subsidies are money transfers by the government that reach the ultimate beneficiary through a formal predetermined route. Direct subsidies increase the beneficiary’s buying power and helps raise the living standards. In agriculture, direct subsidies help farmers buy the necessary inputs from the market. For e.g., PM KISAN, Minimum Support Price (MSP) and Direct Benefit Transfer (DBT).

Indirect Subsidies: Indirect subsidies are provided through price reduction, welfare and other ways but do not include a direct cash payment. They reach the farmers along with the use of inputs. Farmers get the subsidized product while the subsidy amount is provided to the provider of the product. For e.g., fertilizer subsidy, power subsidy, water subsidy, etc.

7.2. Issues related to the agricultural subsidies.

1. Agricultural subsidies lead to a heavy **fiscal burden** on the government. The total outgo on fertilizer subsidy alone in 2017-18 was Rs. 70,000 crores.
2. Power subsidy has led to **overuse of groundwater** which has further resulted into dramatic fall in ground water levels.
3. Due to the fertilizer subsidy being offered, there has been an **indiscriminate use of fertilizers** by the farmers. This has led to a **decline in soil fertility** and an overall reduced agricultural productivity.
4. Fertilizer subsidies are generally **cornered by the manufacturers and the rich farmers** of Punjab and Haryana and it fails to provide benefits to the targeted groups, especially small and marginal farmers.
5. Price subsidies like Minimum Support Price (MSP) are **cereal centric** (rice, wheat etc.) and have neglected pulses, oil seeds and coarse cereals.
6. Most of the subsidies are **regionally biased** and have benefitted the rich states which are able to grow marketable surplus and have well developed infrastructure. States like Bihar and Eastern U.P have failed to derive similar benefits.

In order to resolve the various issues related to agricultural subsidies, following steps could be taken:

1. Better targeting of subsidies with the usage of JAM (JanDhan-Aadhar-Mobile Number) trinity can reduce the fiscal burden.
2. Government needs to rationalize certain subsidies like power subsidy to check indiscriminate exploitation of groundwater.
3. Promotion of soil health card, organic farming and neem coated urea can reduce the quantum of fertilizers used in agricultural fields. This will rationalize the fertilizer subsidies which has already put a heavy fiscal strain on the government.
4. Direct Benefit Transfer (DBT) of subsidies through Aadhar authentication will solve issues like inclusion-exclusion errors and ensure better targeting of beneficiaries.
5. Crop diversification by including more crops under Minimum Support Price (MSP) will benefits such farmers growing those crops.

7.3. Agricultural Subsidies and World Trade Organization (WTO)

Some of the notable agreements under the WTO are as follows:

1. **Agreement on Sanitary and Phytosanitary Measures (SPS)** sets out the basic rules for food safety and animal and plant health standards.

2. **Agreement on Agriculture (AoA)** under which, 1st and 3rd world countries are required to limit their food subsidies to 5% and 10% respectively to the value of their agriculture production in 1986.
3. **Peace Clause** which gives temporary immunity India and other developing countries to continue their respective food subsidy programs and protects them from being challenged under other WTO agreements by countries like U.S.A.

Agreement on agriculture (AoA) aims to regulate the agricultural subsidies through its “box” mechanism.

1. “**Green Box** (subsidies that don’t disrupt trade or only cause minimum damage to trade balance)” and “**Blue Box** (subsidies that aim to limit production and don’t increase with production)” subsidies are allowed. E.g., subsidies given for research and cattle-vaccination.
2. “**Amber Box**” subsidies are subjected to quantitative limits as they are trade distorting in nature. E.g., subsidies on diesel, electricity and fertilizer, Minimum Support Price (MSP) etc.

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8. Public Distribution System

Public distribution system in India is a government sponsored chain of shops entrusted with the task of distributing basic food and non-food items to the needy sections of the society at very cheap prices. The PDS distributed commodities worth more than Rs 98,000 crore in 2014-15 through 5.21 lakh fair price shops. Rice, wheat, sugar, and kerosene have been the four major items of distribution under PDS.

8.1. Objectives of PDS are:

1. To provide essential consumer goods at cheap prices to the consumers.
2. To insulate them from the rising impact of prices of such commodities.
3. To maintain minimum nutritional status of our population.
4. To put indirect check on the open market prices of various commodities.

Public distribution system in India has evolved drastically since the time it was introduced in India.

1. **Targeted Public Distribution System (TPDS)**: It was introduced in 1997 and under it, license was given to panchayats, self-help groups, cooperatives, and individuals to open fair price shops/PDS shops. Beneficiaries can buy commodities like subsidized grains from such shop using their ration cards.
2. **Antyodaya Anna Yojana (AAY)**: It aimed at providing 35 kg subsidized grains for the poorest of poor family at a highly subsidized rate of Rs 2/kg of wheat and Rs 3/kg of rice.
3. **National Food Security Act (NFSA)**: It is a Central Sector Scheme enacted in 2013 by the **Department of Food and Public Distribution under the Consumer Affairs Ministry**. The scheme aims to provide subsidized food grains to poor families. Union procures food grains from farmers at **MSP** and sells it to the states **at Central Issue Price (CIP)**. States then sell the grains to the beneficiaries through fair price shops/PDS shops.

   67% of the Indian population is covered under the scheme, including 75% rural population and 50% urban population (both Below Poverty Line and few Above Poverty Line families are covered). The beneficiaries are provided rice at Rs 3/kg, wheat at Rs 2/kg, and coarse grains at Rs 1/kg.

   The **eldest woman in a household**, of age 18 years or above, is considered the head of the household for issuing ration card. This has been done to promote women empowerment. Further, **pregnant and lactating women** are entitled to "take home ration" of 600 calories per day during pregnancy and six months thereafter.

4. **One Nation One Card**: This scheme aims to connect all ration cards to a central server and provide Point of Sale (PoS) machines to all PDS shops. Doing this will enable all beneficiaries under NFSA to buy grains from any PDS shop in the country, irrespective of the state to which he belongs. The scheme will especially benefit the seasonal migrant workers.

8.2. Issues with PDS in India:

1. After the inclusion of NFSA-2013, the burden of **food subsidy has become huge**. The procurement prices have been rising continuously due to rich farmers' lobby and issue prices are getting lower due to populist policies. All of this together have made PDS unsustainable.
2. **Inefficiencies in the operations of Food Corporation of India (FCI)** due to highly centralized and bureaucratic mode of operations have resulted in an increase in the economic cost of FCI food grains operation.
3. For a long period of time, PDS operations have remained **limited mostly to urban areas** and rural poor have not benefitted much from PDS.
4. Since there is a residential requirement for ration cards, a large number of homeless people, migrants, etc. are automatically left out of food security.
5. PDS suffers from **leakages due to diversion** of foodgrains to the open markets because of widespread prevalence of corruption. NSSO data shows a huge leakage of 37% from PDS in 2011-12.
6. Due to large procurement of foodgrains every year by the government, the net quantities available in the open market reduces. This leads to increase in the price of commodities and inflation.
7. Improper targeting of beneficiaries has led to **inclusion-exclusion errors**. As per NSS-2007, 63% of the poor households were not covered under the TPDS system. Further, NCAER reported about "ghost" card holders/ghost beneficiaries.

8.3. Way Forward

1. **Shanta Kumar committee** in 2015 **recommended gradual introduction of cash transfers** in PDS, starting with large cities with more than 1 million population.
2. **Food coupons** can be provided to beneficiaries through which they can buy foodgrains from store, and the dealer could be reimbursed on production of these coupons at the govt treasure. This will help reduce the problems of procurements, diversion and black marketing of food grains.
3. Instead of buying through PDS, government should provide a **universal basic income** to all so that the needy could purchase foodgrains as per their choice.
4. **Private sector** should be encouraged to take up procurement, storage and distribution of foodgrains. This would ease the pressure on government agencies and increase efficiency.
5. Government should **diversify its procurement basket** so as to incorporate adequate nutrient mix. This will promote crop diversification and check the skewed incentive to grow only rice and wheat.

6. **Technological intervention** is the need of the hour in the PDS system. For e.g., truck dispatch information and stock availability at fair price shop through SMS to registered users and GPS based tracking of trucks carrying PDS goods can be implemented.
7. Fair price shops can be operated with the help of panchayats, cooperatives and self-help groups will lead to **community participation** and localized monitoring of PDS scheme.
8. **Proper identification of beneficiaries** will improve targeting. Creating a web database of beneficiaries with information on the allotted quantity of each good as per entitlement, computerized entry via Aadhar authentication at Point of Sale (PoS) machines, etc. can be done.

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9. Income Support to Farmers

NABARD's **All India Rural Financial Inclusion Survey 2016-17** made the following observations:

1. Around 10 crore rural households out of 21 crore households are engaged in agriculture. However, the monthly average agricultural household income was a mere **Rs 8,931 in 2016-17**.
2. Even for the so-called agricultural households, just over 43% of their average income comes from cultivation of crops and rearing of animals.
3. 41% of the rural households are indebted, of which majority are agricultural households (43%).
4. Only 26% of the agricultural households out of the total rural households have any kind of insurance.
5. Only around 53% of agricultural households report savings in a financial institution indicating low levels of financial inclusion.

The above findings conclude that farm income levels are not satisfactory, making agriculture a non- profitable enterprise. A sound income level gives a sense of security to the farmers and encourages him to take risks. Having a high income promotes farmers to invest more in agriculture by adopting new technologies and purchasing better inputs (high quality seeds and fertilizers), which effectively increases agricultural productivity. A fair level of farm income also leads to socio-economic development of farming households, reduces rural indebtedness and minimizes farmer suicides.

9.1. PM KISAN

PM KISAN is a Central Sector Scheme implemented by the Agriculture Ministry in which all farmers, irrespective of farm size, will get up to Rs 6,000 per year as minimum income support. The amount will be paid to each eligible farmer in three instalments and will be deposited directly to their bank accounts.

The **objectives of PM KISAN** are as follows:

1. To augment the income of the Small and Marginal Farmers (SMFs).
2. To supplement the financial needs of SMFs in procuring various inputs to ensure proper crop health and appropriate yields, commensurate with the anticipated farm income at the end of each crop cycle.
3. To protect SMFs from falling into the clutches of moneylenders for meeting such expenses and ensure their continuance in farming activities.

9.2. PM KISAN MAAN DHAN YOJANA

Government has launched the PM Kisan Maan Dhan Yojana (PM-KMY) with a view to provide **social security to Small and Marginal Farmers (SMFs)** in their old age when they have no means of livelihood and minimal or no savings to take care of their expenses.

Under the scheme, a monthly fixed pension of Rs 3000 is provided to the small and marginal farmers, subject to certain exclusion criteria, on attaining the age of 60 years. It is a voluntary and contributory pension scheme. The eligible farmer is required to contribute to a Pension Fund between Rs. 55 and Rs. 200 per month depending on the entry age. The Central Government contributes an equal amount to the Pension Fund.

Small and Marginal Farmers (a farmer who owns cultivable land up to 2 hectares as per the land records of the state) in the age bracket 18-40 years are eligible to join the pension scheme. Farmers who are **not eligible** to join the scheme includes:

1. Small/Marginal farmers who joined PM Shram Yogi Maan Dhan Yojana, National Pension Scheme, EPFO or any other government run pension scheme.
2. Farmers owning more than 2 hectares of land.
3. All persons who have paid Income Tax in the last assessment year.

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10. Introduction to Agriculture

Definition

- Agriculture is the **science, art and practice of cultivating plants and livestock**.
- Aka it is the science or practice of farming, including cultivation of the soil for the growing of crops and therearing of animals to provide food, wool, and other products.
- It was the **key development in the rise of sedentary human civilization**, whereby farming of domesticated speciescreated food surpluses that enabled people to live in cities

10.1. Types of Agriculture

Subsistence Agriculture

- It is the **cultivation of small and scattered holdings** with the help of draught animals and family members with **primitive techniques**. It is practiced by majority of farmers across the world.

Nomadic Herding

- It is based upon the **rearing of animals on natural pastures**. This practice is performed by the people of **semiarid and arid regions**. This is a subsistence type of activity.

Plantation agriculture

- It was **introduced in India by Britishers** and involves growing and processing of a single crop purely meant forsale.
- Examples include plantations of **Tea, Rubber, Coffee, Cocoa** etc.
- Practiced mainly in **Assam, sub-Himalayan, West Bengal, Nilgiri, Annamalai and Cardamom Hills**.

Shifting agriculture

- Aka Jhum Agriculture. It involves **clearing of forest land by felling and burning and then growing crops**.
- The land is abandoned in 2-3 years after the fertility of the soil is lost. It is practiced by nearly 250 millionpeople, especially in **North East India** and in the tropical rain forests of **South America, Central and WestAfrica, and Southeast Asia**.

Livestock Ranching

- Under this system of farming, the major emphasis is laid on **rearing animals**.
- Unlike nomadic herding, the farmers live a **settled life**. This type of farming has developed on a commercial basis in areas of the world where large plots of land are available for animal grazing, such as the low rainfallareas of **North America, South America and Australia**.

Commercial Grain Farming

- This type of farming is a **response to farm mechanization** and is the major type of farming in the areas withlow rainfall and population.
- These crops are **prone to the vagaries of weather and droughts**, and monoculture of wheat is the generalpractice.
- Prairies, steppes, and temperate grasslands of **South America, Australia** &**New Zealand** are the main areas forthis type of farming.

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Agriculture

Chapter 3

Short Answers

CSM-05: Compiled by Prof. Ashok Vishandass

22

This chapter contains:

- Timeline of Agriculture in India
- Status of Agriculture in India
- Soil
- Soil Profile
- Types of soil
- Soil process
- Crops
- Major crops in India
- Other crops
- System and patterns in agriculture

Contents

1. Timeline of Agriculture in India

Early History

- By 9000 BCE, **Wheat& Barley** were domesticated in the Indian subcontinent. This was soon followed bydomestication of sheep and goat.
- During the Indus Valley Civilization, **cotton** was well developed & **rice** was also cultivated.
- **Mixed farming** was developed. Around 4500BCE, irrigation developed.

Vedic period & Post Mahajanapadas period

- In the later Vedic texts, there are evidences of use of **iron**, this led to cultivation of a wide range of **cereals,vegetables, and fruits** are described. The soil was ploughed several times.
- **Meat and milk products** were part of the diet as animal husbandry was important.

The Mauryan Empire

- Soils were **categorized and meteorological observations for agricultural** use were prepared.
- In addition, the administration facilitated construction and maintenance of **dams**, and provision of **horse-drawn chariots**.

Early Medieval

- The **Tamil people** cultivated a wide range of crops such as **rice, sugarcane, millets, black pepper, variousgrains, coconuts, beans, cotton etc.**
- **Systematic ploughing, manuring, weeding, irrigation and crop protection** was practiced for sustainedagriculture.
- Spice trade involving gained momentum as India started **shipping spices to the Mediterranean**.

Medieval

- There were **advancements in Irrigation technologies** along with division of agricultural 'Zones' into producingrice, wheat or millets.
  - Cultivation of **tobacco** (**introduced by the Portuguese**) spread rapidly.
  - **Malabar Coast** became the home of spices, especially **black pepper**.
  - **New species of fruit**, such as the **pineapple, papaya, and cashew nut**, also were introduced by the Portuguese.
- Land management was particularly strong especially during the regime of Akbar, under whom Todarmal formulated and implemented elaborated methods for agricultural management.

Colonial Era

- Agriculture in India during this time was marked by a **downward spiral**. The new methods of land revenuesystem led to massive agrarian distress and poverty.

- In addition, deliberate **de-industrialisation** led to massive pressure of land leading to further poverty.
- The emphasis on **commercial cropsover food crops** led to series of famines and increases risks for agriculture.
- The state of agriculture during the interwar period was even more tragic and marked by high population growth but almost **stagnant food output**. The crisis was most acute in Bengal leading to **infamous Bengalfamine of 1943.**

Post-Independence

- India was faced problems initially, like of **food shortage, war with Pakistan** and **refugee crisis**. Thus, tacklingfood shortage became utmost priority and formed the basis of first five-year plan.
- Gradually, there was a more coherent and balanced approach to agricultural development.
  - "**Agenda of Land reforms**"→ development of Dams →"**Temples of Modern India**".
  - **Grow More Food Campaign** (1940s) and the **Integrated Production Programme** (1950s) focused on foodand cash crops supply respectively.
  - Later, **land reclamation, land development, mechanization, electrification, use of chemicals-fertilizers** in particular, and development of agriculture oriented 'package approach' of taking a set of actions instead ofpromoting single aspect soon followed under government supervision.
  - ***Production reforms from 1960s***: **Green Revolution**; **Yellow Revolution** (Oilseed 1986-1990), **Operation Flood** (Dairy 1970-1996), and **Blue Revolution** (Fishing 1973-2002) etc.
  - *Institutional support-* Indian Council of Agricultural Research; Dairy Development Board; National Bankfor Agriculture and Rural Development
- ***Post 1991***, Growth in agricultural sector benefiting from the earlier reforms and the newer innovations ofAgro-processing and Biotechnology.

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2. Status of Agriculture in India

Presently:

- **Food security** as well as export house for the world; **Contract farming** along with e-commerce in agriculture is propelling agricultural sector; **Organic farming** has become a major potential for export.

Challenges:

- **Declining public expenditure**, **small landholdings**, **exposure to global glut** in agri-commodities, **inadequate governance** capacity continue to create problems for India's farmers.

Ministries

Ministry of Agriculture and Farmers Welfare

- Department of Agriculture, Cooperation and Farmers Welfare
  - **Statutory:** Coconut Development Board, National Cooperative Development Corporation, Protection of
Plant Varieties and Farmers' Rights Authority, Registrar of Multi State Cooperative Societies.
  - **Attached Office:** National Rainfed Area Authority.
  - **CPSE:** National Seeds Corporation Ltd. (NSC)
  - **Autonomous/ Cooperative bodies:** NAFED, Small Farmers Agribusiness Consortium (SFAC). Various boards/ institutes for horticulture, plant health management, Agro marketing etc.
- Department of Agricultural Research & Education
  - Autonomous body: Indian Council of Agricultural Research (ICAR)
  - Central Agro universities @Imphal (Manipur), Pusa (Bihar), Jhansi (UP)

Ministry for Fisheries, Animal Husbandry and Dairying

- Dept of Fisheries
- **Dept of Animal Husbandry and Dairying**
  - **Statutory:** National Dairy Development Board (NDDB)

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3. Soil

Definition

➢ Soil is the thin top layer on the earth's crust comprising rock particles mixed with organic matter.
➢ **Pedology** is the study of soils in their natural environment.
➢ **Pedogenesis** is the natural process of soil formation that includes a variety of processes such as weathering,leaching, calcification etc.

Factor Affecting Soils

Parent Material

- The **rocks from which soils are formed** are called parent materials. Mostly, it **determines the colouration, mineral composition and texture** of the soil.
- Exceptions, the soil formed may or may not have the same physical properties as the parent rock.
- Rocks come under the influence of many processes and factors that **changes the physical as well as chemicalproperties of rock** like weathering, climate change, etc.
- **In Indian Conditions**, parent material is generally categorized into:

▪ Ancient crystalline and metamorphic rocks
- Oldest rocks of **Pre-Cambrian era**, formed due to **solidification of molten magma** about 4 billion yearsago.
- **Features:** Forms the '**Basement Complex'** of peninsular India; basically **granites, gneisses and schists**; rich in **ferromagnetic materials** and give rise to red soils on weathering (due to the presence of iron oxide)

▪ Cuddapah and Vindhyan rocks
- **Ancient sedimentary rocks** (4000 m thick);
- **Features:** Upon weathering, they give rise to**calcareous** (containing calcium carbonate) and **argillaceous** (consisting of or containing clay) soils; **devoid of metalliferous minerals**.

▪ Gondwana rocks
- **Sedimentary rocks**
- **Features:** Much younger than others; upon weathering, they give rise to comparatively **less mature soils**; It is more or less of uniform character but of low fertility.

▪ Deccan basalts
- Formed due to a **volcanic outburst** over Peninsular India gave rise to Deccan Traps.
- **Features:** formation of fissures; Rich in **titanium, magnetite, aluminium and magnesium**; upon weathering, they give rise to soils of darker colour; high moisture holding capacity →regur or black cotton soil.

Relief

- Second most important factor in places with steep slopes like the hilly regions, edges of plateaus etc.
- **Soil erosion** on barren slopes is rampant, and it **hinders soil formation**.
- **Example**: Chambal ravines, higher reaches of the Himalayas where there is minimal or no forest cover(most on the steep southern slopes) etc.
- The areas of **low relief or gentle slope** generally **experience deposition** and have deep soils.
- **Example**: Indo-Gangetic plain.
- Exceptions: river basins where the soil layers are sufficiently deep.

Climate (Again)

- **Temperature and rainfall** play most important role in soil formation; It determines the effectiveness ofweathering of the parent material, the quantity of water seeping through the soil and the type of microorganisms present therein.
- As, two different parent materials may develop the same soil in the same type of climate. Similarly, the same parent material may produce two different types of soils in two different types of climates.
- The **crystalline granites produce laterite** (reddish clayey soils) soil in relatively moist parts of the monsoonal region and non- laterite soil in drier areas.
- **Hot summer and low rainfall** develop **black soil** as is found in **some parts of Tamil Nadu** irrespective of theparent rock.
- In **Rajasthan**, both **granite and sandstone** give birth to **sandy soil** under arid climate.
- In **arid and semi-arid regions**, **evaporation always exceeds precipitation**. There is **little vegetation**, and the soils badly lack humus content. Hence the soils are invariably of **light colour**.
- In Rajasthan and the adjoining arid and semi-arid regions, an **excess of evaporation makes soils limeaccumulating**. Hence, the soil is **pedocal in nature**.
- In cold climates of the **Himalayan region**, the process of **vegetation decay** is **very slow**, and the **soils areacidic** in nature.

Natural Vegetation

- It reflects the **combined effects of relief and climate**.
- It **influences formation & development of soil**: The decayed leaf material adds much-needed humus to soilthereby increasing its fertility; the densely forested areas contain some of the best soils in India.

Components

Clay

- Very **fine particles**; **Compacts easily**; Forms large, **dense clumps** when wet; **Low permeability** to water;therefore, **upper layers become waterlogged**.

Gravel

- **Coarse particles**; Consists of **rock fragments**.

Loam

- About equal **mixtures of clay, sand, slit, andhumus**; **Rich in nutrients**; **Holds water** but does not becomewaterlogged.

Sand

- Sedimentary material **coarser than slit**; **Water flows through too quickly** for most crops; **good for crops** andplants requiring low amounts of water.

Silt

- Sedimentary material consisting of **very fine particles** betweenthe size of sand and clay; **easily transported** by water.

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4. Soil Profile

Basics

- The **vertical section of the soil showing the various layers from the surface to the unaffected parent material** is known as a **soil profile**. The various layers are known as horizons.
- Each layer differs in feel (texture), colour, depth and chemical composition.

O Horizon

- It is a **surface horizon** that is comprised of **organic material** at various stages of **decomposition**.
- It is most prominent in **forested areas** where there is the **accumulation of debris fallen from trees**.
- Layers dominated by **organic material**; Some O layers consist of **undecomposed or partially decomposed litter** (such as leaves, needles, twigs, moss, and lichens).

A Horizon

- It is a **surface horizon** that largely consists of **minerals (sand, silt, and clay)** and with appreciable amounts of **organic matter**. This horizon is predominantly the surface layer of many soils **in grasslands and agricultural lands.** It is part of the top soil.
- Here, organic matter is mixed with mineral matter.
- This layer is depleted of (eluviated of) iron, clay, aluminium, organic compounds, and other soluble constituents.

E Horizon

- It is a **subsurface horizon that has been heavily leached** (of clay, iron, and aluminium oxides, which leaves a concentration of resistant minerals, such as quartz, in the sand and silt sizes).
- It is typically **light in color** & is **present only in older, well-developed soils**, and generally, occur **between the Aand B horizons.**

B Horizon

- It is a **site of deposition** of certain minerals that have leached from the layer(s) above.
- Thus, **iron, clay, aluminium and organic compounds accumulate in this horizon** (illuviation (opposite ofeluviation)).

C Horizon

- A subsurface horizon; **least weathered**; **aka saprolite**; formed of **large unbroken rocks.**
- It may **accumulate more soluble compounds** (inorganic material).

R Horizon

- It largely comprises **continuous masses of hard rock**.
- Soils formed in situ will exhibit strong similarities to this **bedrock layer**.
- These areas of bedrock are **under 50 feet** of the other profiles.

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5. Types of Soil

- ➢ The soil is classified on the basis of the **proportion of particles ofvarious sizes**.

- ▪ If the soil contains a greater proportion of big particles, it iscalled sandy soil.
- ✓ **Water can drain quickly** through the spaces between thesand particles;
- ✓ So, sandy soils tend to be **light in color, well aerated anddry**.

- ▪ If the proportion of fine particles is relatively higher, then it iscalled clayey soil.
- ✓ Clay particles, being much smaller, pack tightly together, leaving little space for air.
- ✓ Unlike sandy soil, **water can be held in the tiny gaps** between the particles of clay.

- ▪ If the amount of large and fine particles is about the same, then the soil is called loamy.
- ✓ **Loamy soil is a mixture of sand, clay** and **another type ofsoil particle known as silt**.
- ✓ The loamy soil also has **humus** in it. It **has the right water holding capacity** for the growth of plants.

- ➢ Crops vs Soils
- ▪ Clayey and loamy soils are both suitable for growing cereals like wheat, and gram. Such soils are good atretaining water.
- ▪ For paddy, soils rich in clay and organic matter and having a good capacity to retain water are ideal.
- ▪ For lentils (masoor) and other pulses, loamy soils, which drain water easily, are required.
- ▪ For cotton, sandy loam or loam, which drain water easily and can hold plenty of air, are more suitable.

Major Soil Groups

Basics

- Geologically, Indian soils can broadly be divided into soils of peninsular India and soils of extra- peninsularIndia.
- **The soils of the Extra-Peninsula** (Indo- Gangetic-Brahmaputra plains) are formed due to the **depositionalwork of rivers and wind**. They are **very deep**. They are often referred to as **transported or azonal soils**.
- **The soils of Peninsular India** are formed by the **decomposition of rocks in situ**, i.e. directly from the underlying rocks. They are **transported and redeposited** to a limited extent and are known as **sedentary soils**.

Alluvial Soils

- About
  - These are formed mainly **due to silt deposited by Indo-Gangetic-Brahmaputra rivers**[Rocks of theHimalayas forms the parent material]
  - In **coastal regions**, they are **formed due to wave action**.
  - It is the largest soil group covering about **45.6% the total area & supports> 40% of India's population**.

- Characteristics
  - **Immature**; have **weak soil profiles**; **loamy soil type**- **highly porous**; **Pebbly and gravelly soils are rare**; **Kankar** (calcareous concretions) beds are present along the river terraces; **Porosity and texture** provide **good drainage** and other conditions **favourable for agriculture**; **replenished itself**.

- Chemical properties
  - **Low in Nitrogen**; **Adequate in potash, phosphoric acid** (phosphate) and **alkalis** (lime); Wide range of Iron oxide and lime.

- **Distribution**
  - Along the **Indo-Gangetic-Brahmaputra plains** except in few places where the top layer is covered by desertsand.
  - Present in deltas of **the Mahanadi, the Godavari, the Krishna and the Cauvery**, where they are called **deltaic alluvium** (coastal alluvium).
  - Some alluvial soils are found in the **Narmada, Tapti valleys** and **Northern parts of Gujarat**.

- Crops
  - Best suited for **agriculture;** responds well to the **canal and well/tube-well irrigation**.
  - They yield splendid **crops of rice, wheat, sugarcane, tobacco, cotton, jute, maize, oilseeds**, etc.

- Geological Divisions

- Geologically, the alluvium of the Great plain of India is **divided into newer or younger khadar and olderbhangar soils**.

Black Soils

- About
  - The **parent material**= **volcanic rocks** that were formed in the **DeccanPlateau.**
  - In **Tamil Nadu**, **gneisses and schists** form the parent material.
  - These are the region of **high temperature and low rainfall**.

- Characteristics
  - **Highly argillaceous** (containing clay) with a **large clay factor, 62%** or more; **uploads** type black soils have **low fertility** while those in the **valleys are very fertile**; have **high retentive of moisture**; gets **sticky during rainy season**; **shrinks during summers** (develops deep cracks).
  - The lower layers can still retain moisture. The cracks permit oxygenation of the soil to sufficient depths.

- Chemical properties
  - The black colour is due to the presence of a **small proportion of titaniferous magnetite or iron and black** constituents of the parent rock.
  - In **Tamil Nadu** and parts of **Andhra Pradesh**, the black colour is derived from crystalline schists and basicgneisses.

- Color
  - **10% of alumina;9-10% of iron oxide;6-8% of lime & magnesium carbonates; potashis variable** (less than 0.5%); **phosphates, nitrogen & humus are low**.

- Distribution
  - Spread over **16.6% of the total area**across **Maharashtra, Madhya Pradesh, parts of Karnataka, Telangana,Andhra Pradesh, Gujarat and Tamil Nadu.**

- Crops
  - Best suited for **cotton crop** aka regur and black cotton soils.
  - Other major crops:**wheat, jowar, linseed, virginia tobacco, castor, sunflower and millets**.
  - **Rice and sugarcane** are equally important where irrigation facilities are available; Large varieties ofvegetables and fruits are also successfully grown on the black soils.

Red Soils

- About
  - It forms one of the **largest soil group of India**.
  - The main **parent rocks** are **crystalline and metamorphic rocks** like acid granites, gneisses and quartzites.

- Characteristics
  - The **texture** of these soils can vary from **sand to clay**, the **majority beingloams**.
  - Uplands are poor, gravelly, and porous |Lowlands are rich, deep dark and fertile.

- **Chemical properties**
  - Acidic with fair alkali content.
  - **poor in lime, magnesia, phosphates, nitrogen & hum**us; | **Rich in potash & potassium**.

- Color
  - The red colour is due to the **presence of iron oxide.**

- Distribution
  - Found in regions of **low rainfall**; Covers **10.6 %** of the total area.
  - Spread across Tamil Nadu, Karnataka, south-east of Maharashtra, Telangana, Andhra Pradesh, Madhya Pradesh, Chhattisgarh, Odisha, Chota Nagpur plateau; parts of south Bihar, West Bengal, Uttar Pradesh; Aravallis and the eastern half of Rajasthan (Mewar or Marwar Plateau), parts of North-Eastern states.

- **Crops**
  - The red soils are **mostly loamy**, thus with the **proper use of fertilisers and irrigation techniques**, give a **goodyield** of cotton, **wheat, rice, pulses, millets, tobacco, oilseeds, potatoes and fruits**.

Laterite Soils

- About
  - **Formed due to weathering; under conditions of high temperature and heavy rainfall with alternate wet and dry periods.**
  - **Heavy rainfall promotes leaching** (nutrients gets washed away by water) of soil whereby lime and silica are leached away, and a soil **rich in oxides of iron and aluminium compounds is left behind**.
  - Laterite soils are **red in colour due to little clay and more gravel of redsand-stones**.

- Chemical properties
  - **Rich in bauxite or ferric oxides**; **Poor in lime, magnesia, potash and nitrogen**; **High phosphate content insome areas**; **Wetter areas may have high humus content**.

- Distribution
  - Covers 2.48 lakh sq km; spread across the **summits of Western Ghats at 1000 to 1500 m** above mean sealevel, **Eastern Ghats, the Rajmahal Hills, Vindhyan, Satpuras and Malwa Plateau**.
  - They are well developed in **south Maharashtra, parts of Karnataka** etc. and are widely scattered in otherregions.

- Crops
  - **Low fertility** due to intensive leaching, but **when manured and irrigated**, they are **suitable for growing plantation crops like tea, coffee, rubber, cinchona, coconut, arecanut, etc**.

- Economic Value
  - Laterite and lateritic soils **provide valuable building material**.
  - These soils can be **easily cut into cakes but hardens like iron when exposed to air**.
  - As it is the end-product of weathering, it **cannot be weathered much further and is durable**.

Forest- Mountain Soils

- About
  - The desert soils **consist of aeolian sand (90 to 95%) and clay (5 to 10%).**
  - The formation of these soils is mainly governed by the characteristic deposition of organic matter derived from forests and their character changes with parent rocks, ground- configuration and climate.

- Chemical properties
  - **Rich in humus**; **deficient in potash, phosphorus and lime**; **require a good deal of fertilisers for high yields**.

- Distribution
  - Covers 2.85 lakh sq km or **8.67% of total area**;
  - In the **Himalayan region**, such soils are mainly **found in valleys, less steep and north facing slopes**.
  - The south-facing slopes are very steep & exposed to denudation and hence do not support soil formation.
  - Forest soils occur in **Western and Eastern Ghats** also.

- Crops
  - Suitable for **plantations of tea, coffee, spices and tropical fruits in the peninsular forest** region.
  - **Wheat, maize, barley and temperate fruits** are grown in the Himalayan forest region.

Arid- Desert Soils

- About
  - The presence of **sand inhibits soil growth**.
  - **Desertification of neighbouring soils is common** due to the intrusion of aeolian sand (wind action).

- Chemical properties
  - **Poor in organic matter**;

- They are alkaline with **varying degree of soluble salts** like **calcium carbonate**. **Calcium content increases downwards**, and the **subsoil hasten times more calcium**.
- **High phosphate content**; **Low Nitrogen** in most areas where nitrates are absent.

➢ Distribution
- Cover a **total area of 1.42 lakh sq km (4.32%);** Spread across **arid and semi-arid regions** of **Rajasthan,Punjab and Haryana.**
- **Sandy soils without clay factor** are also common in **coastal regions of Odisha, Tamil Nadu & Kerala**.

➢ Crops
- **Phosphates and nitrates make these soils fertile wherever moisture is available.**
- In large areas, only the drought resistant and **salt tolerant crops such as barley, cotton, millets, maize andpulses are grown**.

Saline- Alkaline Soils

➢ About
- Here, the **top soil is impregnated with saline and alkaline efflorescence's** (become covered with salt particles).
- Undecomposed rock fragments, on weathering, give rise to sodium, magnesium and calcium salts and sulphurous acid. Some of the salts are transported in solution by the rivers.
- In regions with the low water table, the salts percolate into subsoil and in regions with good drainage, thesalts are wasted away by flowing water.
- But in places where the drainage system is poor, the water with high salt concentration becomes stagnant and deposits all the salts in the topsoil once the water evaporates.
- In regions with the high sub-soil water table, injurious salts are transferred from below by the capillaryaction as a result of evaporation in the dry season.

➢ Distribution
- Spread across 68,000 sq km of area.; **found in canal irrigated areas and areas of a high sub-soil watertable**.
- Parts of **Andhra Pradesh, Telangana, Karnataka, Bihar, Uttar Pradesh, Haryana, Punjab** (side effects of improper or excess irrigation), **Rajasthan and Maharashtra** have this kind of soils.
- The **accumulation of these salts makes the soil infertile and renders it unfit for agriculture**.

Peaty- Marshy Soils

➢ About
- Have **large amount of organic matter** and a **considerable amount ofsoluble salts**.
- The most humid regions have this type of soil.

➢ Chemical properties

- **Deficient in potash and phosphate**; They are **black, heavy and highlyacidic**.

- Distribution
  - Spread across **Kottayam and Alappuzha districts of Kerala**.
  - Also occur in the coastal areas of Odisha and Tamil Nadu, Sundarbans of West Bengal, in Bihar andAlmora district of Uttarakhand.

- **Crops**
  - **Most of the peaty soils are under water during the rainy season** but as soon the rains cease; they are putunder paddy cultivation.

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6. Soil Process

Podzolization

- A process of **soil formation: formation of Podzols and Podzolic soils**.
- Podzolization is the **negative of calcification** [The calcification process tends to concentrate calcium in the lower part of the B horizon, whereas podzolization leaches the entire solum of calcium carbonates]
- The **other bases along with calcium are also removed** and the whole soil becomes distinctly acidic. In fact, the process is essentially one of the processes of acid leaching.

Laterization

- The term laterite meaning **brick or tile** and was originally applied to a group of high clay Indian soils found in Malabar hills of Kerala, Tamil Nadu, Karnataka and Maharashtra.
- It refers specifically to a particular cemented horizon in certain soils which when dried, become very hard,like a brick.
- **Laterization** is **the process that removes silica, instead of sesquioxides from the upper layers and therebyleaving sesquioxides to concentrate in the solum**.

Gleization

- It is a process of **soil formation resulting in the development of a glei** (or gley horizon) in the lower part of the soil profile above the parent material due to poor drainage condition (lack of oxygen) and where waterlogged conditions prevail. Such soils are called **hydro-orphic soils**.

Salinization

- It is the process of **accumulation of salts**, such as sulphates and chlorides of calcium, magnesium, sodium and potassium, in soils in the form of a salty (salic) horizon. It is quite **common in arid and semi-arid regions**.
- It may also take place **through capillary rise of saline ground water** and by **inundation with seawater in marine and coastal soils.**
- Salt accumulation may also result from irrigation or seepage in areas of impeded drainage.

Desalinization

- It is the **removal of excess soluble salts by leaching from horizons or soil profile** (that contained enough soluble salts to impair the plant growth) by ponding water and improving the drainage conditions by installing artificial drainage network.

Solonization or Alkalization

- The process involves **the accumulation of sodium ions on the exchange complex of**

the clay, **resulting in theformation of sodic soils** (Solonetz).

- All cations in solution are engaged in a reversible reaction with the exchange sites on the clay and organicmatter particles.

Solodization or dealkalization

- The process refers to the **removal of Na+ from the exchange sites**. This process **involves dispersion of clay**.Dispersion occurs when Na+ ions become hydrated.
- **Much of the dispersion can be eliminated if Ca++ and or Mg++ ions are concentrated in the water**, which isused to leach the soonest. These Ca and Mg ion can replace the Na on exchange complex, and the salts of sodium are leached out.

Desertification

- ***Definition:*** Productive potential of arid or semi-arid land falls by at least 10% due to human activity and/orclimate change.
- ***Symptoms:*** Loss of native vegetation; increased wind erosion; salinization; drop in water table; reduce surfacewater supply.
- ***Remediation:*** Reduce overgrazing; reduce deforestation; reduce destructive forms of planting, irrigation, andmining. Plant trees and grasses to hold soil.

Salinization

- ***Definition:*** Water that is not absorbed into the soil and evaporates **leaves behind dissolved salts** in topsoil.
- ***Symptoms:*** Stunned crop growth; lower yield; eventual destruction of plant life.
- ***Remediation:*** Take land out of production for a while; and/or install underground perforated drainage pipes;flush soil with freshwater into separate lined evaporation ponds; plant halophytes (salt-loving plants) such asbarley, cotton, sugar beet and/or semi-dwarf wheat.

Water logging

- ***Definition:*** Saturation of soil with water resulting in a **rise in the water table**.
- ***Symptoms:*** Saline water **envelops deep roots killing plants**; **lowers productivity**; **eventual destruction ofplant life**
- ***Remediation:*** Switch to less water-demanding plants in areas susceptible to water logging; utilize conservation- tillage farming; plant water logging-resistant trees with deep roots; take and out of productionfor a while; and/ or install pumping stations with drainage pipes that lead to catchment-evaporation basins.
- Loam soils generally contain more nutrients and humus than sandy soils, have better infiltration anddrainage than silty soils and are easier to till than clay soils.
- If the topsoil is brown or black, it is rich in nitrogen and is good for crops. If the topsoil is grey, yellow, orred, it is low in organic matter and poor for crops.

Erosion

- ***Splash Erosion***: 1st stage of erosion process; occurs **when raindrops hit bare soil**.
- The explosive impact breaks up soil aggregates so that individual soil particles are 'splashed' onto the soil surface.
- *Sheet Erosion*: the uniform movement of a thin layer of soil across an expanse of land

devoid of vegetativecover.

- Raindrops detach soil particles, which go into solution as runoff occurs and are transported downstream toa point of deposition.
- *Rill Erosion*: When sheet flows begin to concentrate on the land surface, rill erosion occurs.
- While sheet erosion is generally invisible, rill erosion leaves visible scouring on the landscape. This type of erosion occurs when the duration or intensity of rain increases and runoff volumes accelerate.
- *Gully Erosion*: Rill erosion evolves into gully erosion as duration or intensity of rain continues to increase and runoff volumes continue to accelerate.
- It is generally defined as a scoured-out area that is not crossable with tillage or grading equipment.

Some Terms

Soil Texture

- It refers to the relati**ve proportion of particles or it is the relative percentage by weight of the three soilseparates** viz., sand, silt and clay or simply refers to the size of soil particles.
- Loam: A type of soil texture with good water holding capacity and drainage suitable for cultivation of variety ofcrops.

Soil Structure

- The **arrangement and organization of primary and secondary particles in a soil mass** is known as soilstructure.

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7. Crops

Basics

Terms69

- ➢ ***Crops:*** A crop is **a plant or animal product that can be grown and harvested extensively for profit or subsistence**. Crops may refer either to the harvested parts or to the harvest in a more refined state.
- ➢ ***Cropping pattern*** refers to the **proportion of area under different crops at any given point of time in a unitarea**.
- ➢ Crop Arrangement:
- ▪ ***Temporal Arrangements*** (time) refers to the **yearly sequence of growing different crops on a piece ofland**.
- ▪ ***Spatial Arrangements*** (space/land) refers to **the arrangement of crop/s on a piece of land in variouspatterns**.
- ➢ ***Crop diversification*** refers to **the addition of new crops or cropping systems to agricultural production on a particular farm** considering the different returns from value-added crops with complementary marketing opportunities
- ➢ ***Crop rotation***: **Crops are changed in the field from year to year according to a planned sequence** rather than the same crop being grown in the same field again and again.
- ➢ C***ropping System*** is a broader term than cropping pattern and **includes the sum total of all crops and the practices used to grow those crops on a field or farm**. It comprises of all components, such as water, soil, technology etc. required for the production of a particular crop and the interrelationships between them and the surrounding environment.
- ➢ ***Cropping Intensity***: It refers to **number of crops cultivated in a piece of land per annum**.
- ➢ ***Gross Cropped Area***: It is the **total area sown once as well as more than once in a particular year**.

Factor Affecting

- ➢ ***Agronomic/Technical***
- ▪ **Climate and soil type** (irrigation, topography, fertility, drainage etc.);
- ▪ **Availability of required inputs** (fertilizer, chemical, credit, tractors etc.);
- ▪ **Plant/seed of high genetic quality;**
- ▪ **Management techniques** and quality managers;
- ▪ Abundance of labour.

- ➢ ***Economic***
- ▪ **Flow of market signals and communication and information systems**, Ex: regarding prices in the market,supply- demand etc;
- ▪ Venture capital and entrepreneurship;
- ▪ **Transparency of input and output prices**;
- ▪ Information on export standards, market demand and relative profitability;
- ▪ Efficient marketing systems.

- ***Government Policy***
  - **Non-distortionary policy** to avoid discrimination among crops. (eg. MSP Policy);
  - **Efficient research** and **extension programmes**, without any bias for major crops or against high valuecrops;
  - Contract-farming opportunities;
  - **Rural cr**edit;
  - Off-farm employment opportunities;
  - **Marketing systems** including quality standards;
  - Involvement of the private sector.

Classification of Crops

Based on End Usage

- ***Food Crops***
  - The crops which are grown as **food for the producer's family or for the producer's own livestock**.
  - Generally, produced at small scale (subsistence level) | Ex: wheat, rice, jowar etc.

- ***Cash Crops***
  - The crops that are especially used for **profit rather than consumption by a family**.
  - They can be **consumed directly or processed** into other products, such as **sugar and biofuel**.
  - They consist of foods like **tobacco, tea, coffee, cardamom, fruits and vegetables, grains**, etc.
  - They are sold, but some are not edible. Cotton and tobacco are examples of non-edible cash crops.

- ***Plantation Crops***
  - It refers to those crops which are **usually cultivated as a single crop on an extensive scale** in a largecontiguous area, owned and managed by an Individual or a company.
  - These plantation crops are of **high value commercial crops of greater economic importance**. The crops include tea, coffee, rubber, cocoa, coconut, arecanut, oil palm, cashew, cinchona etc.

- ***Horticulture crops***
  - **The science and art of growing and caring for plants**, especially flowers, fruits, and vegetables.
  - The word horticulture comes from Latin and means "**garden cultivation**"
  - Whereas agronomy (a branch of agriculture) refers to the **growing of field crops**, horticulture refers to **small-scale gardening**.
  - All food crops can be cash crops but not all cash crops can be food crops. Food crops can be eaten by someone somewhere and so have a cash value. Food crops can be sold, which would make them cash crops as well.

Based on Season

- ***Kharif Crop:***
- The crops grown in monsoon months from **June to Oct-Nov**;**Require warm**, **wet weather at major period of crop growth**, also required short day length for flowering. Ex: *Cotton, Rice, Jowar, bajara*.

- ✓ ***Northern States***: *Rice, Cotton, Bajra, Maize, Jowar, Tur*
- ✓ ***Southern States***: *Rice, Maize, Ragi, Jowar, Groundnut*

- ***Rabi Crop:***
- The crops grown in **winter season from Oct to March month**. Crops grow well in **cold and dry weather**. Require **longer day** length for flowering. Ex:*Wheat, gram, sunflower* etc.

- ✓ ***Northern States***: *Wheat, Gram, Rapeseeds and Mustard, Barley*
- ✓ ***Southern States***: *Rice, Maize, Ragi Groundnut, Jowar*

- ***Zaid Crop:***
- The crops grown in **summer month from March to June**. Require **warm-dry weather** for major growth period and **longer day length for flowering**. Ex:*Groundnuts, Watermelon, Pumpkins, Gourds*.

- ✓ ***Northern States***: *Vegetables, Fruits, Fodder*
- ✓ ***Southern States***: *Rice, Vegetables, Fodder*

Based on Climate

- ***Tropical Climate Crop***: They grow well in **warm & hot climate**. Ex:*Rice, sugarcane, Jowar etc*
- ***Temperate Climate Crop***: They grow well in **cool climate**. Ex:*Wheat, Oats, Gram, Potato etc*

Based on Agronomics

- ***Cereals***
- They are cultivated **grasses grown for their edible starchy grains**. Larger grains used as staple food arecereals.
- Ex: *Rice, wheat, maize, barley and oats*. The important cereal of world is rice.

- ***Millets***
- They are also **annual grasses of the group cereals**. But they are grown in less area or less important areawhose productivity and economics are also less.

- These are staple food of poor people. In India pearl millet is a staple food in Rajasthan

- ✓ **Major millets** (based on area production and productivity and grain size)
  - o *Sorghum /Jowar; Pearl Millet /Bajra/cumbu; Finger millet or ragi, etc*
- ✓ **Minor millets** (based on area production and productivity and grain size)
  - o *Fox tail millet; Little millet; Common millet; Barnyard millet; Kodomillet, etc*

- ➢ ***Pulses or Grain Legumes***
- Major source of protein in Indian diet; economically, **pulses are cheapest source of protein**.
- It is cultivated to **enrich the soil**, to **utilize the residual moisture** and to give **revenue in a shorter period**.
- Ex: Red gram; Black gram; Green gram; Cowpea; Bengalgram; Horsegram; Dewgram; Soyabean; Peas, etc

- ➢ ***Oil Seed Crops***
- These crops are **cultivated for the production of oil**.
- Either for **edible** or**industrial or medicinal purpose**. They **containfat**.
- *Groundnut or peanut; Sesamum or gingelly; Sunflower; Castor; Linseed or flax; Niger; Safflower; Rapeseed& Mustard*; 45 – 50% oil content is present in these seeds.

- ➢ ***Sugar Crops:*** Juice extracted from
- ✓ ***Sugar stem*** used for jaggery or sugar
- ✓ Number of by products like *Molasses, bagasse, press-mud*;
- ✓ Molasses used for **alcohol and yeast formation**; **Bagasse** for paper making and fuel;
- ✓ Press- mud used for **soil amendment; Trash (green leaf + dry foliage)**- the waste is used for cattle feed;

- ***Sugar beet***: Tuber for extraction of sugar
- ✓ *Tubers and tops* are used as a fodder for cattle feed.

- ➢ ***Starch Crops or Tuber Crops***
- ✓ *Potato; Tapioca or cassava; Sweet potato, etc*

- ➢ ***Fibre Crops***
- **Epidermal hairs of seed coats are the economic portion**; Lint (cappas- seed) has industrial value (fibre);
- Stalk is of fuel nature, garment purpose, seed for cattle feed and Oil is edible;

- ➢ ***Cotton***
- Karunganni; Uppam cotton; American cotton or Cambodium cotton; Egyptian cotton

or Sea island cotton

- ➢ ***Stem Fibres***
- Jute; Mesta; Sun hemp; Sisal hemp, etc

- ➢ ***Narcotics***
- Stimulates Nervous System- Tobacco; Betelvine; Arecanut, etc

- ➢ ***Forage and Fodder Crops***
- The entire **vegetative part** is used as **green fodder;**
- The **stalks and leaves** are the major economic portion for hay making;
- Hay is cut into pieces and mixed with concentrated animal feed and is fed to animals.

- ➢ ***Grasses***
- *Napier grass; Para grass; Bermuda grass; Guinea grass; Rhodes grass, etc*

- ➢ ***Legumes***
- Lucerne (Alfalfa); Egyptian clover (Bersemm); Indian clover (Fodder senji); Sirato; Stylo; Subabul, etc

- ➢ ***Plantation Crops***
- Tea (leaf); Coffee (seed); Rubber (milk exudation); Cocoa (Seed).

- ➢ ***Spices and Condiments***
- Products of crop plants are used to flavor taste and sometime color the fresh preserved food. Ex: *ginger, garlic, chili, cumin onion, coriander, cardamom, pepper, turmeric* etc.
- Medicinal plants include cinchona, isabgoli, opium poppy, senna, belladonna, rauwolfra, iycorice.
- Aromatic plants such as lemon grass, citronella grass, palmorsa, Japanese mint, peppermint, rose, jasmine,henna etc.

Based on Duration of Crops

- ➢ ***Seasonal crops***:A crop completes its life cycle in one season. Ex: *rice, Jowar, wheat,* etc.
- ➢ ***Two seasonal crops***: Crops complete its life cycle in two seasons. Ex: *Cotton, Turmeric, Ginger.*
- ➢ ***Annual crops***: Crops require one full year to complete its life cycle. Ex: *Sugarcane.*
- ➢ ***Biennial crops***: Crops requires two year to complete its life cycle Ex: *Banana, Papaya.*
- ➢ ***Perennial crops***: Crops live for several years. Ex: *Fruit crops, mango, guava etc.*

Based on Cultural Method/Water

- ➢ ***Rain fed:*** Cultivation of crop mainly based on the **availability of rain water**. Ex:

Jowar, Bajara, Mung etc.

- ***Irrigated crops:*** Crops cultivated with the help of **irrigation water**. Ex: *Chili, sugarcane, Banana, papaya* etc.

Based on Root System

- ***Tap root system***: The main **root goes deep into the soil**. Ex: *Tur, Grape, Cotton* etc.
- ***Fiber rooted***: The crops whose roots are **fibrous shallow & spreading into the soil**. Ex: *Cereal crops, wheat, rice* etc.

Based on Economic Importance

- ***Cash crop:*** Grown for **earning money**. Ex: Sugarcane, cotton.
- ***Food crops:*** Grown for **raising food grain for the population and & fodder for cattle**. Ex: Jowar, wheat, riceetc.

Based on No. of Cotyledons

- ***Monocots or monocotyledons:*** Having **one cotyledon in the seed**. Ex: *all cereals & Millets*.
- ***Dicots or dicotyledonous:*** Crops having **two cotyledons in the seed**. Ex: *all legumes & pulses and almost all thetrees*.

Based on length of photo period required for floral initiation

- ***Photoperiodism:*** The effect of light on plant. Most plants are **influenced by relative length of the day & night**, especially for floral initiation, depending on the length of photoperiod required for floral ignition, plants are classified as:
- ***Short-day plants:*** Flower initiation takes place when days are short **less than ten hours**. Ex: *rice, Jowar, green gram, black gram etc.*
- ***Long day's plants:*** require long days are **more than ten hours** for floral initiation. Ex: *Wheat, Barley, etc*.
- ***Day neutral plants:*** Photoperiod does not have much influence for phase change for these plants. Ex: *Cotton, sunflower, etc.*

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8. Major Crops in India

Wheat

- ***About***
  - 2^{nd} most important crop; **Main food crop in north** and **north-western India**; **Rabi Crop.**

- ***Climatic Conditions***
  - Requires a cool growing season and a bright sunshine at the time of ripening.
  - **Winter temperature from 10°-15° C** and **summer temperature from 21°-26° C**; **50-75 cm of annual rainfall** evenly distributed over the growing seasons.

- ***Extra***
  - The **Ganga-Satluj plains** in the northwest and black soil region of the Deccan.
  - The **major wheat-producing states** are **Punjab, Haryana, Uttar Pradesh, Bihar, Rajasthan and parts of Madhya Pradesh.**
  - India is 4th largest wheat producer with about 1/8th of world output.

Rice

- ***About***
  - **Staple food crop** of India; **Kharif Crop**; **Aus, Aman and Boro** are varieties of rice in Kharif, Rabi and Zaid seasons.

- ***Climatic Conditions***
  - High **temperature (above 25° C)**; High Humidity with **average rainfall above 100 cm.**

- ***Extra***
  - Plains of **North and North-Eastern India**, **coastal areas and the deltaic regions.**
  - With help of **Irrigation: Punjab, Haryana, West UP and Parts of Rajasthan.**
  - Other areas: West **Bengal, Andhra Pradesh, Tamil Nadu.**
  - **Staple food crop** of India; India is the **second largest producer** after China.

Pulses

- ***About***
  - Major source of **protein in a vegetarian diet**; Major Pulses: **Tur (arhar), urad, moong, masur, peas and gram.**

- ***Climatic Conditions***
  - **less moisture** and **survive even in dry conditions**; Gram prefers **20°-25° temperature** and **40-50 cm rainfall.**

- ***Extra***
  - Major pulse producing states in India are **Madhya Pradesh, Uttar Pradesh,**

Rajasthan, Maharashtra and Karnataka.

- **India is the largest producer and consumer.**
- **Leguminous plants-Help in restoring fertility.**

Millets

- ***About***
- **Jowar, bajra and ragi are important millets** in India; Have **highnutritional value.**

- ***Climatic Conditions***
- J**owar** is a rain-fed crop mostly grown in the moist areas which **hardly needs irrigation**. **(Kharif- 26°-33° C;Rabi- above 16°C)**.
- **Bajra** grows well on sandy soils and shallow black soil **(Temperature- 25°- 30° C; rainfall- 40-50 cm).**
- Ragiis a crop of dry regions and grows well on red, black, sandy, loamy and shallow black soils (Temperature- 20°-30° C; rainfall- 50-100 cm).

- ***Extra***
- ***Major Jowar producing States*** were **Maharashtra, Karnataka, Andhra Pradesh and Madhya Pradesh**.
- ***Major Bajra producing States*** were: **Rajasthan, Uttar Pradesh, Maharashtra, Gujarat and Haryana**.
- ***Major ragi producing states*** are: **Karnataka, Tamil Nadu, Andra, Himachal Pradesh, Uttarakhand, Sikkim,Jharkhand and Arunachal Pradesh**.
- **Alternative to rice**; India leads world production in millets.

Maize

- ***About***
- Is used both as **food and fodder**; **A Kharif Crop**; In some states like Bihar-Rabi crop also.

- ***Climatic Conditions***
- Temperature between **21°C to 27°C** and grows well in **old alluvial soil**; **50-100 cm rainfall.**
- **Requires four and a half frost free months in a year.**

- ***Extra***
- ***Major maize-producing states*** are **Karnataka, Uttar Pradesh, Bihar, Andhra Pradesh, Telangana,Rajasthan and Madhya Pradesh.**
- Used as Food and fodder crop; Production of crop increased due to use of HYV seeds, fertilisers andirrigation; **Rich in protein.**

Cotton

- ➢ ***About***
  - Fibre Crop;**Kharif Crop** and requires **6 to 8 months to mature**.
  - Cotton grows well in drier parts of the black cotton soil of the **DeccanPlateau**.
- ➢ ***Climatic Conditions***
  - It requires **high temperature (21° -30° C), light rainfall (50-100 cm) orirrigation, 210 frost-free days** and **bright sun-shine** for its growth.
- ➢ ***Extra***
  - ***Major cotton-producing states*** are-**Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Andhra Pradesh, Telangana, Tamil Nadu, Punjab, Haryana and Uttar Pradesh**.
  - Originated in India; **2nd largest producer in world; Light weight crop; Non-perishable raw material.**
  - Cotton quickly exhausts fertility of soil; hence regular use of manure and fertilisers is required.

Tea

- ➢ ***About***
  - **Plantation Crop**
- ➢ ***Climatic Conditions***
    - Grows well in **tropical and sub-tropical climates** endowed with **deep andfertile well-drained soil**, **rich in humus and organic matter**.
  - Ideal temperature- **20°-30° C;**Requires **warm and moist frost-freeclimate** all through the year.
  - **Frequent showers (150-300 cm)** evenly distributed over the year ensure continuous growth of tenderleaves.
- ➢ ***Extra***
  - Tea is a labour-intensive industry; It requires abundant, cheap and skilled labour.
  - ***Major tea-producing states*** are **Assam, hills of Darjeeling and Jalpaiguri districts, West Bengal, Tamil Nadu and Kerala. Himachal Pradesh, Uttarakhand, Meghalaya, Andhra Pradesh and Tripura** are also tea-producing states in the country.
  - **Tropical and sub-tropical climates**; **Well drained soil** where does notstagnate; One of the **major foreign exchange earners** of India.

Coffee

- ➢ ***About***

- The **Arabica variety** initially **brought from Yemen** is produced in the country.

- ***Climatic Conditions***
  - Requires **hot and humid climate** with temperature varying between **15°-28° C** and rainfall from **150-250cm**; **Hot and humid climate.**
  - ***Harmful*: Prolonged drought& frost; Stagnant water.**
  - ***Soil:* Iron and calcium, humus and minerals** rich soil ideal- well drained rich friable loams Must be properlymanured (to retain & replenish fertility).

- ***Extra***
  - Initially, its cultivation was introduced on the **Baba Budan Hills** and even today its cultivation is confined tothe **Nilgiri in Karnataka, Kerala and Tamil Nadu**.
  - India produces about **4% of world coffee production**; Arabica variety is popular.
  - Almost **50% of Indian production is exported.**

Rubber

- ***About***
  - **Equatorial Crop**, but under special conditions it's also grown in **tropical and sub-tropical areas**.

- ***Climatic Conditions***
  - **Moist and humid climate** with rainfall of more than 200 cm. andtemperature above 25°C.
  - **Harmful: Dry spell and low temperature**. Daily rainfall followed by strongsun is very useful.

- ***Extra***
  - **Mainly grown in Kerala, Tamil Nadu, Karnataka and Andaman and Nicobar Islands and Garo hills of Meghalaya**; Rubber plantations were **first established in Kerala in 1902.**
  - **Important industrial raw material**; **India is 3rd largest producer in world.**

Sugarcane

- ***About***
  - **Tropical as well as subtropical crop**; **Main source of sugar, gur (jaggary), khandsari and molasses**.

- ***Climatic Conditions***
  - Hot and humid climate with a temperature of **21°C to 27°C** and an annual rainfall between **75cm and 100cm;** Can be grown on a **variety of soils** and needs **manual labour from sowing to harvesting**;
  - ***Soil:*Black, Laterite**

- ***Extra***
  - ***The major sugarcane-producing states*** are **Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Telangana, Bihar, Punjab and Haryana**; Needs manual labour for its cultivation; Perishable.

Jute

- ***About***
  - Known as **Golden fibre**

- ***Climatic Conditions***
  - Grows well on **well-drained fertile soils** in the flood plains where soils are renewed every year.
  - **Temp: 27°C; Rainfall: 120-150 cms** | ***Soil:*****Light sandy or clayey loams.**

- ***Extra***
  - ***Major jute producing states*** are **West Bengal, Bihar, Assam, Odisha and Meghalaya**.
  - Used for making **gunny bags, mats, ropes, yarn, carpets** etc.
  - **Jute getting replaced by synthetic fibres** due to low cost and durability of artificial fibres.

Gram

- ***About***

  - **Rabi crop**; best grown on **loamy soil.**

- ***Climatic Conditions***
  - Temp: **20-25°c**; Rainfall **40-50 cm.**

- ***Extra***
  - **Rajasthan, MadhyaPradesh, Uttar Pradesh, Haryana and Maharashtra**
  - Most important of all pulses; Single or mixed crop with wheat, barley, linseed or mustard.

Tur

- ***About***
  - **Kharif crop** chiefly; **Dry crop mixed** with other kharif crops

- ***Climatic Conditions***
  - Temp: **20-25°C**; Rainfall **40-50 cms**

- ***Extra***
  - **Uttar Pradesh, Madhya Pradesh, Maharashtra, Gujarat, Karnataka**.
  - 2ndmost important millet of India; Seldom grown as single crop.

Tobacco

- ***About:*** **Tropical and sub- tropical climate;** Freedom from frost Needs fertile soils and heavydoses of fertilisers.
- ***Climatic Conditions***: Temp: **16-35°C**; Rainfall: **100cms.**
- ***Extra***: **Andhra Pradesh and Gujarat**; 4th largest producer and 6th largest exporter of tobacco.

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9. Other crops

Groundnut

- ***About***: Kharif crop
- ***Climatic Conditions***: Temp: **21-27°c**; Rainfall: **50- 75cms**;
- Extras***:***
  - ***Enemies:*** Frost, **Prolonged drought, Continuous rain, Stagnant water**
  - ***Producing States***: **Andhra Pradesh, Tamil Nadu, Karnataka, Gujarat, Maharashtra**
  - Accounts for more than 50% of the oilseeds produced in the country Serves as an important rotation crop because it synthesizes atmospheric nitrogen and increases soil fertility

Seasmum

- ***About***: **Rabi crop**
- ***Climatic Conditions***: Temp: **21-23°c**; Rainfall: **45- 50cms**; Soil: **Well drained light loam**
- ***Extras***: **Odisha, Rajasthan, West Bengal, Maharashtra, Gujarat and Madhya Pradesh**

Mustard

- ***About***: **Rabi crops**
- ***Climatic Conditions***: **Cool climate** is suitable
- ***Extras***: **Rajasthan, Uttar Pradesh**; Single crop or mixed with wheat, barley and gram

Linseed

- ***About***: **Rabi Cool**; D**ry crop**
- ***Climatic Conditions***: Temp:**20°c**; Rainfall:**75cms**; Soil: **Clayey, black, Alluvial**
- ***Extras***: **Madhya Pradesh, Uttar Pradesh& Maharashtra**

Castor Seed

- ***About***: Almost whole area of castor seed is rain-fed Kharif crop (north) Rabi crop (South)
- ***Climatic Conditions*** Temp: **20-25°c**; Rainfall: **50- 75cms**;Soil: **Sandy loams** (peninsula) & **Alluvial** (Satluj- Ganga plains)
- ***Extras***: **Gujarat, Andhra Pradesh and Rajasthan**;

Pepper

- ***About***: **Tropical crop**
- ***Climatic Conditions***: Temp: **10-30°c**; Rainfall: **200- 300cms**; Soil: **Loamy**
- ***Extras***: **Kerala, Karnataka, Tamil Nadu**; The plant progresses as a vine and needs support of other trees

Cardamom

- ***Climatic Conditions***: Temp: **15-32°c**; Rainfall: **150- 300cms**; Soil: **Red, Laterite and**

Loamy
- ➢ ***Extras***: **Kerala, Karnataka, Tamil Nadu**; **Shade loving plant** and grown under shade-trees Used inAyurveda

Chillies
- ➢ ***Climatic Conditions***: Temp: **10-30°c**; Rainfall: **60- 125cms**; Soil: **Black and Loamy**
- ➢ ***Extras***: **Andhra Pradesh, Maharashtra and Odisha**

Turmeric
- ➢ ***About***: **Tropical crop**; Soil: **Sandy or loamy**
- ➢ ***Producing States:*** **Andhra Pradesh, Karnataka and Tamil Nadu**;
- ➢ ***Extras***: **King of spices**; Used: Condiment, Healing remedy, Textile Dye

Ginger
- ➢ *About*: Tropical and sub- tropical crop
- ➢ ***Climatic Conditions***: Temp: **10-25°c**; Rainfall: **125- 250cms**; Soil: **Sandy, clayey, Loamy; Red andLaterite**
- ➢ ***Producing States:*** **Kerala, Meghalaya, Sikkim, West Bengal, Odisha and Mizoram** Origin: China

Cashew nut
- ➢ ***Climatic Conditions***: Temp: **16-25°c**; Rainfall: **50-350cms**; Soil: **Laterite (West coast) and Sandy (Eastcoast)**
- ➢ ***Extras***: **Goa, Kerala, Karnataka, Tamil Nadu, Andhra Pradesh & Maharashtra**

Mango
- ➢ ***Climatic Conditions***: Temp: **20-30°c**; Rainfall: **75-250cms**; Soil: prefer **rich clayey loams**
- ➢ ***Extras***: **Uttar Pradesh, Bihar, Andhra Pradesh, West Bengal, Odisha, Kerala, Tamil Nadu,Maharashtra, Gujarat, Karnataka**

Apple
- ➢ ***About***: **Temperate fruit crop**
- ➢ ***Climatic Conditions***: Temp: **21-24°c**; Rainfall: **100-125cms**; Soil: **Loamy, Rich in organic matter**
- ➢ ***Extras***: **Jammu and Kashmir, Himachal Pradesh, Uttaranchal, Arunachal Pradesh**

Banana
- ➢ *About*: Tropical and sub- tropical crop and sub-tropical crop
- ➢ ***Climatic Conditions***: Temp: **20-30°c**; Rainfall: **>150cms**; Soil: **Well drained, Rich in moisture and Humus**
- ➢ ***Extras***: Spread all over India, Peninsular India provide ideal conditions **Tamil Nadu and Maharashtra**
- ▪ Fruit ripens very quickly; Refrigerated boats to ship from tropics to US/EU market;

Banana producing regions nearest to major markets have trade advantage

Orange

- ***Climatic Conditions***: Soil: **Textured sand loams, well- drained**; Root penetration up to2-4meters is best
- ***Extras***: Uttar **Pradesh, West Bengal- Darjeeling, Himachal Pradesh**- Kangra valley, **Meghalaya-** Khasi and Jaintia hills, **Andhra Pradesh-** Hyderabad and Aurangabad, **Karnataka-** Kodagu district, **Kerala**- Wayanad, **Tamil Nadu**- Nilgiri, **Maharashtra**- Nagpur and Pune.
- Orange orchards are rain-fed grown at height of 600- 1500m

Grapes

- ***About***: **Sub-tropical crop**
- ***Climatic Conditions***: **Long summer and short winter**; **Low water supply** in growing period and bright sunshine in mature stage.
- ***Extras***: **Uttar Pradesh, Himachal Pradesh, Jammu and Kashmir and Punjab Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka** | The plant gives only one crop during summer but in South India the plant grows throughout the year and yields two crops a year.

Minor Forest Produce

- ***About***
- MFP is defined under **The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, popularly known as the Forests Rights Act (FRA)**
- The definition of MFP includes **bamboo and cane**, thereby changing the categorization of bamboo and cane as "trees" under the Indian Forest Act 1927.
- PESA, 1996 and Recognition of Forest Rights Act, 2006 conferred ownership of MFP to forest dwellers.
- Forest Rights Act also recognizes and vests individual forest-dwellers with forest rights to own and dispose minor forest products from forests where they had traditional access.

- ***Mechanism*** for marketing of **Minor Forest Produce (MFP) through Minimum Support Price (MSP) anddevelopment of value chain for MFP**
- Launched in 2014, the scheme is designed as a social safety net for improvement of livelihood of MFP gatherers by providing them fair price for the MFPs they collect and ensure sustainable harvesting of MFPs.
- These tribals' then sell the MFPs in village marketplaces.
- If the market prices fall below MSP, the state government agencies move in to procure the produce
- Ministry of Tribal Affairs is the nodal ministry for this scheme.

- ***Significance of MFP in India***
- Around 100 million forest dwellers depend on Minor Forest Produces for food,

shelter, medicines and cash income. (Report of the National Committee on Forest Rights Act, 2011)

- Trials' derive **20-40% of their annual income from Minor Forest Produce** on which they spend majorportion of their time
- As per the **Haque Committee Report**, May 2011, the procurement value of **14 major MFPs is estimated Rs1900 Crores (including tendu & bamboo)**
- This activity has strong linkage to women's financial empowerment as most of the Minor Forest Producesare collected and used/sold by women.

- ***Extra***

- Recently, **Centre revised the minimum support price (MSP) for minor forest produce**, offering much- needed support to tribal gatherers in view of the "exceptional and very difficult" circumstances prevailing in the country due to the coronavirus pandemic
- **Ministry of Tribal Affairs increased the MSP of 49 products** which are collected by tribals from forests
- This is **done under a Centrally Sponsored scheme** known as "**Mechanism for marketing of Minor Forest Produce (MFP) through Minimum Support Price (MSP) and development of value chain for MFP**" as a measure of social safety for MFP gatherers.
- **Tribal Cooperative Marketing Development Federation of India (TRIFED)**, the nodal agency for the scheme, had recommended the increase to ensure more disposable income for tribals.
- MSP for MFPs is revised once in every 3 years by Pricing Cell constituted under the Ministry of TribalAffairs.

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10. Systems & Patterns in Agriculture

Farming Systems

Basics

- Farm is a piece of land with specific boundaries, where crop and livestock enterprises are taken up undercommon management
- ***Farming*** is the **process of harnessing solar energy in the form of economic plant and animal products**
- System is a set of components which are interdependent and interacting

Wetland Farming

- ***Wet land***: soils flooded or **irrigated through lake, pond or canal** and **land** is always in submerged condition
- ***Wetland farming***: is the practice of **growing crops in soils flooded** through natural flow ofwater for most part of the year

Garden Farming

- ***Garden land***: soils **irrigated with ground water sources**
- ***Garden land farming***: **Growing crops with supplemental irrigation** by lifting water fromunderground sources.

Dryland Farming

- ***Dry land***: soils purely depends rainfall for moisture
- ***Dryland farming***: is the practice of crop **production entirely depending upon rainfall** and the moisture conserved in the soil
- This is practiced in areas where **annual rainfall is less than 750mm**.
- The crops may face moisture stress frequently due to erratic distribution or failure of monsoon

Rainfed Farming

- Crop production in areas where **rainfall is more than 750mm** (i.e assured rainfall areas).
- Here **moisture stress will be minimum**. Soil conservation is given more importance

Mixed Farming

- ***Mixed farming*** is defined as a **system of farming on a particular farm whichincludes crop production, raising livestock, poultry, fisheries, bee keeping etc**. to sustain and satisfy as many needs of the farmer as possible.
- **Subsistence is important objective of mixed farming**. While higher profitability without altering ecological balance is important in farmingsystem.

- ***Advantages***
- It **offers highest return** on farm business, as the **by- products** of farm are
- **properly utilized**

- [The crop by-products such as straw, fodder etc. is used for feeding of livestock and in return they providemilk; Manures available from livestock to maintain soil fertility]
- It provides **work throughout year**; **Efficient utilization** of land, labour, equipment and other **resources.**
- It helps in **supplying all the food needs of the family members.**

Specialized Farming

- The farm in which **50% or more income of total crop production is derived from a single crop** is calledspecialized farming

Diversified Farming

- A diversified farming has several production enterprises or sources of income but **no source of income equal as much as 50% of the total income**. It is also called as **general farming**.

Cropping Systems

About:

- The cropping system of a region is a cumulative result of long-term agricultural practices, social customs and traditions, physical conditions, Government policies, monetary considerations and historical factors.
- The **change in land use pattern and cropping pattern is vastly affected by irrigation expansion, infrastructuredevelopment, penetration of rural markets, development and spread of short duration and drought resistant crop technologies, rapid urbanization**.
- The higher cultivable area has been achieved by bringing large acreage of uncultivable land into cultivation.

Mono-Cropping

- It refers to growing of only one crop on a piece of land year after year.
- It may be **due to climatic and socio-economic conditions** or due to **specialisation of a farmer** in growing a particular crop.
- Ex: Groundnut or cotton or sorghum are grown year after year due to limitation of rainfall, while in canal irrigated areas, under a waterlogged condition, rice crop is grown as it is not possible to grow any other crop.
- ***Sole cropping***: One crop variety grown alone in a pure stand at normaldensity.
- ***Monoculture***: Repetitive growing of the same sole crop in the same land.

Multiple Cropping

- It is the practice of growing two or more crops in the same field within a given year.
- It is the **intensification of cropping in time and space dimensions**, i.e. a greater number of crops within yearand a greater number of crops on same piece of land in any given period.

Mixed cropping

- **Growing of two or more crops simultaneously intermingled without row arrangement** is known as mixed cropping.
- It is a **common practice in most of dryland tracts** in India.
- The objective is **subsistence farming;** to meet the family requirement of cereals, pulses and vegetables.
- Ex: Sorghum, Bajra and cowpea are mixed and broad- casted in rainfed conditions (with low rainfall situations) to avoid complete crop failures andwith ascertaining the minimum yields

Inter-cropping

- ***Base crop***: The primary crop which is planted/ sown at its optimum sole crop population in an intercropping situation.
- ***Intercrop***: This is a second crop planted in between rows of base crop with a view to obtain extra yields with intercrop without compromise inthe main crop yields

- ***Requirements***:
  - The **timing of peak nutrient demands** of component crops **should not overlap**.
  - **Competition for light should be minimum** among the component crops.
  - The **difference in maturity** of component crops **should be at least 30 days**.
  - Ex: Maize + Cowpea (1:1); Sorghum + Redgram (2:2); Groundnut + Redgram (6:1); Potato + Mustard (3:1);Wheat + Mustard (8:1)

Row intercropping

- Growing two or more crops simultaneously where one or more crops areplanted in rows.
- It is a variation in space dimension.
- Ex: maize + greengram (1:1), maize + blackgram (1:1), groundnut + redgram(6:1).

Strip-intercropping

- Two or more crops are planted in the same field in alternate strips.
- Strips are **wide enough to permit independent cultivation** but **narrow enough for thecrops to interact**.
- Ex: groundnut + redgram (6:4) strip.

Parellel cropping

- Growing of **two crops simultaneously which have different growth habits** and **no competition** amongthemselves
- Ex: Blackgram with maize; Soybean with cotton

Synergestic Cropping

- Yields of both crops are higher than of their pure crops on unit area basis
- Ex: Sugarcane + Potato

Multi storey cropping

- Cultivation of more than **two crops of different heights simultaneously on a pieceof**

land in any certain period
- Ex: Coconut + Pepper + cocoa + pineapple

Sequential Cropping

- It can be defined as **growing of two or more crops in a sequence on same piece of land in a farming year**.
- The **succeeding crop is planted after the preceding crop has been harvested**. There is no competition
- Its various types are:
- ***Double Cropping***: Growing two crops on the same land in a year in sequence. Ex: rice→cotton
- ***Triple Cropping***: Growing three on the same land in a year in sequence. Ex: Triple cropping: rice→rice→pulses
- ***Quadruple***: Growing four crops on the same land in a year in sequence. Ex:tomato→ridgegourd→amaranthus greens→baby corn.

Alley cropping

- It is a system in which **food crops are grown in alleys formed by hedge rowsof trees or shrubs**.
- The essential feature of the system is that **hedge rows are cut back at planting** and ke**pt pruned during cropping to prevent shading** and to **reduce competition** with food crops.
- **The space between two rows called alleys**; The intercrops are raised in the alley space
- Ex: cotton, sorghum, blackgram | Ex: Subabul raised at 6 m row spacing;

Relay cropping

- In a **long duration base crop, growing two sets of inter-crops one after another** is calledrelay intercropping
- Ex: Redgram- base crop 180 days; Groundnut/onion/coriander-I set of intercrops; Samai/thenai/panivaragu- 2nd set of intercrops

Ratoon cropping

- Ratooning is a method of harvesting a crop which leaves the roots and the lower parts of the plant uncut to give the ratoon or the stubble crop. Crop regrows out of roots or stalks after harvest of crops.
- ***Benefit:*** The crop **matures earlier** in the season+ It can also **decrease the cost of preparing the field and planting.**
- Ratooning is most often used with crops which are known to give a steady yield for three years under most conditions eg sugarcane, banana, pineapple.
- However, this method cannot be used endlessly as the yield of the ratoon crop decreases after each cycle.
- Ex: Sugarcane (8 ratoons in Cuba)
- **Banana- one plant crop** followed by two ratoon crops normally
- **Sorghum and Lucerne fodder**- many ratoons 1stcutting 70 DAS and thereafter every

35-40 days

- **Pineapple crop** is extensively ratooned.

Crop Rotation

- The practice of growing of different crops on a piece of land is a pre- planned succession.
- The principle behind is to **utilise the available resources to the fullest extent** in order to harvest the maximum in a unit land without affecting the soil health. Ex- Rice-Red Gram –Banana

- ***Practical examples of effective crop rotation***:
- Leguminous crops should be grown before non-leguminous crops
- ✓ Because legumes fix atmospheric N into the soil and add organicmatter to the soil.
- **Crops with tap roots** (deep rooted like cotton) **should be followed by those which have fibrous** (shallow rooted crops like sorghum or maize)**root system**.
- ✓ This facilitates proper and uniform use of nutrients from the soil.
- More exhaustive crops should be followed by less exhaustive crops
- ✓ Because crops like potato, sugarcane, maize etc. need more inputs such as better tillage, morefertilizers, greater number of irrigations etc.
- Selection of crop should be based on need or demand
- **Crops of same family should not be grown in succession**
- ✓ Because they act as alternate hosts for insect pests and diseases
- The selection of crops should suit farmers financial conditions
- **The crop selected should also suit to the soil and climatic condition**

Cropping Pattern

About

- Cropping pattern refers to the proportion of area under different crops at any given point of time in a unitarea.

Factors

- ***Geographical factors***

- ***Soil***
- ✓ **Soil conditions**: soil pH, salinity, ground water table, soil topography and soil texture
- ✓ **Soil pH**: tea grows in acidic soil where coconut needs alkaline soil to grow well
- ✓ **Salinity**: Crops do not grow well in saline soil. So, we need to develop saline tolerant varieties for saline area. But few crops like tomatoes and broccoli may grow in moderately saline water
- ✓ **Ground water table**: Shallow rooted crops do not grow well in that area where water table is low
- ✓ **Soil topography**: Sesame, pineapple, zinger, turmeric etc., grows well in that land which are not underflood water but pulses, oil seeds grows well in those land where little flood water comes usually

- ✓ **Soil texture**: Sweet potato, groundnut, water melon grows well in sandy land but rice needs clay orsandy clay soil
- ✓ **Soil water**: Rice needs more soil water than any other crops

- ***Terrain***
- ✓ Slope also **determine nature of crop**| Example: Tea in hilly areas whereas, rice and jute in plains

- ***Climate***
- ✓ **Humidity:** Some crops like tea grow well in high humidity.
- ✓ **Day length:** Potato grows well in short day length whereas wheat, onion need long day length.
- ✓ **Rainfall:** Tea needs heavy rainfall whereas barley and chickpea grow in arid climate.
- ✓ **Temperature:** In temperate countries wheat grows well whereas in sub-tropical area rice is grows well.

➢ ***Infrastructural facilities***

- Irrigation, transport, storage, trade and marketing, post-harvest handling and processing etc.

➢ ***Social factors***- Land Tenancy, Size of land holdings, Size of fields, etc

- **Financial condition**: Poor farmer cannot grow expensive crops like sugarcane, Banana etc. (high initial cost)
- **Transport problem**: Poor communication as well as conveyance facility
- **Market price**: Good market price influence the farmer to grow more crops as well as diversify the set ofcrops to be grown (+technology + storage, etc.)
- **Food habit**: The crops that are not present in the food habit in a locality are usually not grown at thatlocality
- **Storage facility**: Where there is no storage facility, farmers of that locality usually do not grow vegetables(short life)
- **Attitude of farmer**: Sometimes farmers do not want to adopt modern technology

➢ ***Economic factors***

- **MSP:** Minimum Support Price provided to farmers for production of crops Demand based cropping pattern: Cotton cultivation in Vidarbha, Maharashtra, Rice in Punjab and Jute in West Bengal

➢ ***Technological factors***

- If there is no extraction facility, farmer will not cultivate oil seeds
- If there is no shelling facility farmer will not go for corn cultivation.
- Enhanced varieties, cultural requirements, mechanization, plant protection, access to information, etc. arethe factors involved.

- ***Areal factors***
  - It is determined on the basis of areal strength of individual crops.
  - The first, second and third ranking crops of an areal unit may be called as the dominant crops of that unit.
  - These crops, if occupying more or less the same percentage of the total cropped area, shall be competing for area with each other and the farmer will decide which crop may fetch him more profit in a given year under the prevailing rainfall and demand, supply and commodity price condition.
  - Or in the determination of cropping patterns of an area, the minor crops (crops occupying insignificant proportion of the total cropped area) are eliminated.

- ***Relative yield***: With respect to the size of the field + other important factors (input cost, etc.)
- ***Imbalance in pattern of food grain***: Change in **consumption pattern**; Race for **remunerative returns**; Sowing of one type of crops
- ***Government Policies***: MSP; Promotion of cash crops; Nature of policy, crop insurance schemes and facilities to influence farmer to grow a particular crop of a certain area
- ***Production Inputs:*** It is the direct regulator of cropping pattern of region. If there are no available inputs, farmer will not go for production.
- ***Role of man***: The role of man in the cultivation of certain crops in a region is also quite important. Man, by his technological advancement, can ameliorate the physical limits.

Cropping Zones

Wheat Zone

- This region covers the **entire north-western** India including the state of Punjab, Haryana, Uttar Pradesh and Rajasthan.
- The major sub-regions are:
  - ***Wheat-Maize-Sugarcane***: This region comprises a great part of wheat regions, covering **West Uttar Pradesh, Himachal Pradesh and Jammu**.
  - ***Wheat-Jowar-Bajra*** in Indus Plain covering **Punjab and Haryana**.
  - Wheat-Jowar-Bajra in Vindhyan scarp land and Malwa Bundelkhand plateau.

Rice zone

- Rice is considered as the major crop in the vast region stretching from lower Gangetic plain to Brahmaputra valley in the east and the circum-coastal alluvial tracts of the peninsula region.
- Though rice displays overall dominance, considering the secondary importance of other crops, this region may be subdivided into following zones:

- Rice-Jute-Tea: This association of crops occurs in far east, near Assam Valley, north-west Bengal and lower Gangetic plains.
- Rice-Pulses-Millets-: This association occurs in the western section of the former zone, covering central Bihar, eastern Madhya Pradesh and eastern Uttar Pradesh.
- Rice-Millets: This zone comprises the entire Andhra Pradesh, southern Orissa and some parts of Tamil Nadu.
- Rice-Coffee-Spices: This zone is found in the southern extremity of Kerala and Tamil Nadu.

Jowar Bajra Zone

➢ This crop combination is practised in drought prone region (rainfall 50-100 cm).

- Jowar-Cotton in Maharashtra.
- Jowar-Cotton-Oilseeds-Millets in Karnataka and Maharashtra.
- Jowar-Wheat in entire Rajasthan, Haryana and some parts of Uttar Pradesh.
- Bajra-Jowar-Pulses in Rajasthan desert and semi-desert areas.

Cotton Zone

➢ It predominates in the black cotton soil (regur) region in the North West India.

➢ It covers the Deccan trap region and Gujarat plain.

➢ The different sub-regions are

- Cotton-Jowar-Bajra grows in close association with one another in the Maharashtra and Western Madhya Pradesh
- Cotton-Oilseeds combination developed in Gujarat
- Cotton-Pulses-Rice region developed in Narmada banks and Eastern Gujarat.

Millet- Maize Zone

➢ The cultivation of millet, maize and ragi are found in close association with other major cereals like bajra, wheat, rice etc.

➢ Maize cultivation dominates in Rajasthan, Gujarat, and Madhya Pradesh. In Himachal Pradesh, Maize- Barley-wheat combination has developed, particularly in the foothills of the

Himalayas. Some parts of the Aravalli have the peculiar crop combination of Maize-Cotton-Oilseeds-Millets-Wheat. Ragicultivation predominates in South of Karnataka.

➢ Maize has wide adaptability and compatibility under diverse soil and climatic conditions.

➢ It is cultivated in sequence with different crops under various agro-ecologies of the country

Fruit & Spice Zone

➢ This is the smallest region among the different crop regions.

➢ High-altitude hilly areas come under the territory of this region. The 'Duns' and valleysin Himalayas, foothills of Nilgiri, Annamalai, Palni and Cardamom hills in Tamil Nadu and Kerala may be classified as fruit and spice region. Here, the dominant agricultural activity is fruit orchards and plantations.

Others

➢ Plantation and Other Commercial Crops Crops under this category include sugarcane, tobacco, potato, jute, tea, coffee, coconut, rubber and other crops, such as spices and condiments.

➢ Some of them are seasonal, some annual and some perennial. Most of them require specific environmental conditions and from the point of view of cropping patterns, they are concentrated in some particular regions. Besides, certain horticultural crops, such as apple, mango and citrus, are important.

➢ In the case of plantation-crops, intercropping with pulses and fodder crops is common.

➢ Spices and condiments are generally grown on fertile soils. Chillies are rotated with jowar, whereas onion, coriander, turmeric and ginger are grown as mixed crops with other seasonal crop

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Agriculture

Chapter 4

Short Answers

CSM-05: Compiled by Prof. Ashok Vishandass

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This chapter contains:

- Agriculture Status of Agriculture in India
- Area Production and Yield
- Cropping Seasons
- Competitive Advantage & Agriculture Exports
- Employment & Operational Holdings
- Allied Sectors
- Agriculture: Inputs
- Agriculture credit
- Procurement Policy and Issues
- Agriculture Marketing

Contents

1. Agriculture

AGRICULTURE: KEY FACTS & TRENDS

SHARE IN GVA, GROWTH RATES, CAPITAL FORMATION

Share in GVA [Agriculture Statistics at a Glance 2020, Ministry of Agriculture]	• **Share of Agriculture & Allied sectors in Total Gross Value Added (GVA) in 2020-21:** 20% - Crossed 20% first time in the last 17 years. - Higher than World's average (6.4%). - Last 5 Year Trend (2014-15 to 2019-20) - Share of agriculture and allied sectors in Total GVA has been **fluctuating.** • **Share of Various Allied Activities in Total GVA:** Last 5 Year Trend (2014-15 to 2019-20) - **Share of crops** has been **fluctuating.** - **Share of Livestock** has been **steadily increasing.** - **Share of Forestry & logging** has been **fluctuating,** - **Share of Fishing & aquaculture** has increased since 2014-15 (but stagnant since 2017-18). • **Share of Agriculture & Allied Activities in Agriculture GVA** - **Crops –** 60% - **Livestock** – 27% - **Forestry & Logging –** 7% - **Fishing & Aquaculture –** 6%
Growth Rates [Agriculture Statistics at a Glance 2020, Ministry of Agriculture]	• Only sector to have clocked a **positive growth** of 3.4% in 2020-21 (during COVID lockdown). • Last 5 Year Trend (2014-15 to 2019-20) - **Overall -** Growth rate in GVA of agriculture and allied sectors **has been fluctuating.** - **Allied Sectors –** Growth rate in GVA **fluctuating for each sub-sector** (crops, livestock, forestry & logging, & Fishing).
Gross Capital Formation (GCF) in Agriculture & Allied Sectors (as a % of GVA of economy)	• Last 5 Year Trend (2014-15 to 2019-20) - GCF in agriculture and allied sector as a proportion to GVA of Economy has been showing a **fluctuating trend.** - **Private Sector investment > Public**

	Sector Investment - both showing a fluctuating trend.

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2. Area Production and Yield

Land Use Pattern	• **Net Sown Area – 45%** (140 million hectares) Total Area Under Cultivation (Food & Non Food crops)**.** • **Forest Area –** 24% • **Pastures & Groves –** 4%
	• **Cultivable Waste –** 4% • **Fallow Land –** 9% • **Barren and unculturable land** – 5% • **Area under non-agricultural uses –** 8%
Area under Cultivation	• **Foodgrains of India** - Cereals: Rice (23%) > Wheat (15%) **38% of Net Sown Area** - Coarse Cereals/Nutri-cereals: Maize**>** Bajra **>** Jowar **>** Barley > Ragi **11%** - Pulses: Gram/Chickpea/Chana **>** Tur/Pigeon Pea/Arhar **>** Masur/Lentil **15%** • **Other Crops** - Oilseeds – Soyabean > Rape & Mustard Seeds > Groundnut etc. **13%** - Sugarcane - **3%** - Cotton - **7%** - Other – **13%** • **Last 5 Year Trend (2014-15 to 2019-20)** - Total Area under foodgrain, Rice, Wheat, Coarse Cereals, Pulses, Oilseeds, Cotton, Sugarcane – **Fluctuating trend.**
Food grain & Other Crops Production	• Foodgrain production increased from 51 million tonnes in 1950-51 to record production of **297 million tonnes in 2019-20.** • **Rice & Wheat accounted for about 75%** of the food grains production. • **Ranking of Foodgrains on basis of production –** Rice > Wheat > Nutri/Coarse Cereals > Pulses. • **Last 5 Year Trend (2014-15 to 2019-20)** - **Except in 2015-16,** Food grain production has shown an **increasing trend**. - **Rice – Except in 2015-16,** Rice production has shown an **increasing trend**. - **Wheat -** shown an **increasing trend**. - **Coarse cereals** – Fluctuating Trend (Maize **>** Bajra **>** Jowar) - **Pulses** – Fluctuating Trend (Gram > Tur > Masur). - **Oilseeds** - shown an **increasing trend**, except for 2015-16 (Soyabean > Groundnut > Rape & Mustard seeds). - **Cotton, Sugarcane** – Fluctuating trend.

Yield	• **Last 5 Year Trend (2014-15 to 2019-20)** - **Food grain** – increasing trend. - **Rice -** Increasing trend - **Wheat** – Increasing trend (except 2019-20) - **Coarse Cereals, Pulses, Oilseeds, Cotton, Sugarcane –** Fluctuating

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3. Cropping Seasons

Cropping Seasons	**Cropping Season**	**Major Crops Cultivated**	
		Northern States	**Southern States**
	KHARIF (June-Sept)	• **Cereals** – Rice • **Coarse Cereals** - Bajra, Maize, Jowar* • **Pulses** – Tur/Arhar, Urad (Black Gram)*, Moong (Green Gram) • **Oilseeds** – Soyabean, Groundnut • **Other Crops -** Cotton, Sugarcane	Rice, Maize, Ragi, Jowar, Groundnut
	RABI (Oct-March)	• **Cereals –** Wheat • **Coarse Cereals** - Barley, Jowar* • **Pulses -** Gram (Chickpea/ Chana), Peas, Urad (Black Gram)*, Lentil (Masur) • **Oilseeds -** Rapeseeds, Mustards	Rice, Maize, Ragi, Jowar, Groundnut
	Zaid (April-June)	Vegetables, Fruits, Fodder	Rice, Vegetables, Fodder
Key Points to Note	• Majority (60%) of **Foodgrains** are produced in **Kharif Season.** • **Jowar** is both Kharif & Rabi, **but mostly Kharif.** • **70% Oilseeds** produced in **Kharif season** (in Rain-fed Conditions). • **Majority of Pulses** (>55%) are produced in **Rabi Season**.		

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4. Competitive Advantage & Agriculture Exports

Competitive Advantage of Indian Agri- sector [15th Finance Commission HLEG on Exports]	• **Largest arable land resource** in the world. • **20 agri-climatic regions**, all the **15 major climates** in the world exist in India. • India has 46 of the 60 soil types in the world. • India is **2nd highest agriculture producer** in the world (After China). • **Largest producer of** spices, pulses (25%, highest for any one country), milk, tea, cashew, and jute. • **2nd largest producer of** wheat, rice (also largest exporter – 30%), fruits and vegetables, sugarcane, cotton (also 2nd highest exporter), and oilseeds.
Agriculture Exports [HLEG on Exports & Economic Survey 2020-21]	• **India's Agricultural export** – About **2.5% of the world agricultural trade,** and ranks at **10th position** in the world**.** • **Major export destinations -** USA, Saudi Arabia, Iran, Nepal and Bangladesh. • **Key Categories of export -** cereals, fresh fruits and vegetables, processed food, animal products and floriculture.
	• **Marine products, meat, and rice together constitute ~52%** of India's total agri exports. Marine products account for largest share in Agri exports. • **Objective of Agri Export Policy –** increase the share of agricultural exports from present 30 billion USD to more than 60 billion USD by 2022. • **Agri-Imports:** Biggest item is edible oil - worth $10 billion. • **TREND -** Since economic reforms began in 1991, India has remained a **net exporter** of agri-products.

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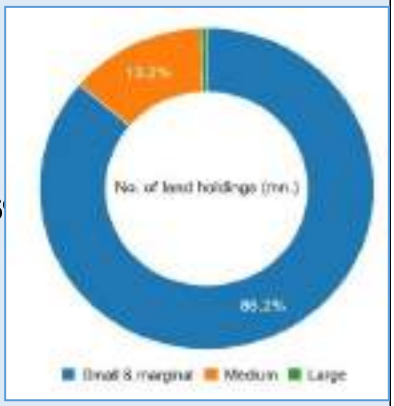
5. Employment & Operational Holdings

Share in Total Employment	• **Share of Agriculture workforce in Total workforce** = 44% (Industry - 28%, Services - 31%) [Periodic Labour Force Survey]. • **70% rural households still depend on agriculture** for their livelihood. • **Share of Landless labourers -** 55% of the total agriculture workforce (More than that of farmers (cultivators)). - **TREND** **-** Share of landless labourers grown more than 5 times since 1951 (Census 2011). • **Small & Marginal Farmers -** 85% of all farmers.
Operational Holdings [Agriculture Census, 2015-16]	Types of Holding • **Marginal (<1 hectare) & Small and marginal holdings (<2 hectares)** – Form **86%** of the total land holdings. • **Semi-medium** (2-4 hectares) & **medium holdings** (4-10 hectares) – form **13%** of total holdings. • **Large holdings** (>10 hectares)**:** form **just 0.6**  • **Last 10 Year Trend**- Number of small land holdings have increased compared to the previous census, while the number of large land holdings has decreased. Size of Holdings • **The average size of operational holding declined** to 1.08 hectares (ha) in 2015-16 compared to 1.15 ha in 2010-11. • **Trend –** Avg. size of landholding **consistently declining** since 1970 Agri Census, indicating greater fragmentation of land.

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6. Allied Sectors

Horticulture	• **Total Contribution to Agriculture GDP** = about 35% (Vegetables, Fruits, Spices, Plantation crops, Flowers & Aromatics). • **% of Net Sown Area** = 16% • **Area under Cultivation** - Vegetables > Fruits > Spices > Plantation crops - **Trend -** Significant Expansion in Acreage (18%) Vis A Vis Foodgrains (5%) – (2010 – 2015).
	• **Production -** 320 million metric tonnes (2019-20). - **Trend -** Production of Horticulture crops has outpaced the production of food grain **since 2012-13.** - **Production - Fruits** (30%) **> Vegetables** (60%) > **Plantation crops** (6%) > **Spices** (2.5%) > **Flowers & Aromatics** (1.5%) - 2nd largest producer of fruits and vegetables in the world. - India is 1st in production of Banana, Mango, Lime and Lemon, Papaya and Okra. - Largest Producer, Consumer, & Exporter of Spices. • **Growth rate of production –** 5.4% p.a (Over the last decade). • **India's Contribution in total world production** – Fruits (12%), Vegetables (13%) • **Share in global exports** - Meagre 1.7% in vegetables and 0.5% in fruits. • **Employment -** supports 20% of the agriculture labour force.
Livestock Sector	• **Livestock sector contribution to agriculture GDP –** 27%. • **Livestock contributed 16%** to the income of small farm households as against an average of 14% for all rural households. • **Livestock provides livelihood to two-third** of rural community and employment to about 9% of the population in India. • **Growth rate -** Nearly 8% over the last five years • **India has Largest Livestock Population in World** - 57% Buffaloes. - 13% Cattles (80% of the cattle are indigenous).
Dairy Sector	• **Dairy sector contribution to livestock sector** (%) - around 65-70% • **India ranks First in Milk Production since last 20 years** 19% of World Production • **Annual growth rate of Milk production** (2014-19) - 6.5% (growth rate of world milk production is 1.2%). • **Trend in last 5 years (2014-15 to 2019-20) -** Milk production **consistently increased.** • **Per capita availability of milk (2018-19)** - 394 grams per day (more than world average). • **Nature of Milk distribution industry** - **Organized sector** - 40% (cooperatives & private dairies) & **unorganised sector** - 60% • **Nature of Milk processing Industry - Organized sector** - 20% &

	unorganised sector - 80%.
Fisheries	• **Fisheries contribution to agriculture GDP –** 6% • **India's Global Position** - Ranks 2nd in Fisheries, 2nd in Aquaculture. - Share in global fish production - 7.7 % • **Fish production (Sub sectors)** - **Fish production (2019-20) -** reached an all-time high of 14 million metric tons - **Marine fisheries** – 35% of total production (includes Coastal & Deep sea fishing) - **Inland fisheries** – 65% of total production (includes Capture & Aqua- culture fishing) • **Average Annual Growth Rate** - 10.8% during 2014-15 to 2018-19 • **Exports -** India is 4th largest fish exporting nation. • **Employment in Sector** - >15 million people engaged fully, partially or in subsidiary activities.

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7. Agriculture: Inputs

KEY FACTS

- **Importance of seed quality -** Seed quality is accounts for **20-25%** of crop productivity.
- **Farmer saved seeds account for 80-85%** of total seeds (which are of low quality).
- **Low seed replacement rates** - below 20% in pulses and below 30% in paddy and wheat.

7.1 Seeds

A. General Definitions:

- Nuclear seed:
  - This is the **100% genetically pure** seed with physical purity and produced by the original breeder/Institute /State Agriculture University (SAU) from basic nucleus seed stock.
  - A pedigree certificate is issued by the producing breeder.

- Breeder Seed:
  - Breeder seed is produced from **nucleus seed** under the supervision of a qualified plant breeder in a research institute of Agricultural University (ie. ICAR - Indian Council of Agricultural Research or SAU).
  - This provides for initial and recurring increase of **foundation seed**.
  - Breeder seed is monitored by a joint inspection team of scientists and officials of certification agency and National Seed Corporation.
  - The genetic purity of breeder seed crop should be maintained **at 100%.**
  - Breeder seed Tag colour **– Yellow.**

- Foundation seed:
  - Foundation seed is the **progeny of breeder seed** and is produced by State Farm Corporation of India, National Seed Corporation, State seed Corporation under technical control of qualified plant breeders or technical officers.
  - Its production is supervised and approved by certification agency.
  - The genetic purity of foundation seed should be maintained **at 99.5%.**
  - Breeder seed Tag colour **– White.**

- Certified seed:
  - Certified seed is the **progeny of foundation seed** and its production is supervised and approved by certification agency.
  - The seed of this class is normally produced by the State and National Seeds Corporation and **Private Seed companies** on the farms of progressive growers.
  - This is the **commercial seed** which is **available to the farmers** and its genetic purity should be **99%.**

- Breeder seed Tag colour **– Azar Blue.**

- **Seed Multiplication Ratio:** It is the number of seeds to be produced from a single seed when it is sown and harvested.
- **Seed Replacement Rate:** Seed Replacement Rate is the percentage of area sown out of total area of crop planted in the season by using certified/quality seeds **other than the farm saved seed**.

SEED RELATED INITIATIVES

A) National Seeds Policy 2002

- **Main objective** - Provision of an appropriate climate for the **seed industry** to utilize available and prospective opportunities, safeguarding of the interests of Indian farmers, and the conservation of agro-biodiversity.

B) Sub-Mission for Seed and Planting Material (SMSP)

- **Various Components -** Seed Village Programme, Establishment of Seed Processing- cum- Seed Storage Godowns at Gram Panchyat Level, National Seed Reserve, Boosting Seed Production in Private Sector and Strengthening of Quality Control Infrastructure Facilities.

C) Seed Village Scheme

- **Seed village concept** is to promote the quality seed production of foundation and certified seed classes. The area which is suitable for raising a particular crop is selected, and raised with single variety of a kind.
- **Objective -** To **upgrade the quality of farmer-saved seed,** which is about 80-85% of the total seed used for crop production programme.
- **By providing financial assistance for:**
  - Foundation/certified seed at 50% cost.
  - Training to farmers on seed production & technology.
  - Assistance for seed storage.
- **Implementing Agencies:** State Departments of Agriculture, State Agriculture Universities, Krishi Vigyan Kendras, State Seeds Corporation, National Seeds Corporation, State Farms Corporation of India (SFCI), State Seeds Certification Agencies, and Department of Seed Certification.

- **Objective -** to produce and supply quality seeds to farmers to enhance production and productivity.

7.2 Fertilizer

Indian soil is deficient in key nutrients. **Judicious and optimum use** of fertilisers and organic manures, thus, hold the key to improving farm productivity through provision of essential nutrients.

A. Macro and Micro Nutrients

- 16 elements are considered essential for plant growth.
- **Carbon (C), hydrogen (H) and oxygen (O)** are the most abundant elements in plants.
- The remaining 13 essential elements are classified as **macronutrients** and **micronutrients.**

- Macronutrients**:**
  - **Primary Nutrients** - Nitrogen (N), Phosphorus (P), Potassium (K) **-** Most fertilizers that are commonly used in agriculture contain these three basic plant nutrients (NPK)
  - **Secondary Nutrients -** Sulphur (S), Calcium (Ca) and Magnesium (Mg).
- **Micronutrients:**
  - Iron (Fe), Zinc (Zn), Manganese (Mn), Copper (Cu), Boron (B), Chlorine (Cl) and Molybdenum (Mo).
  - **Five additional elements** – Sodium (Na), Cobalt (Co), Vanadium (Va), Nickel (Ni) and Silicon (Si) have been established as essential micronutrients in some plants.
  - Micronutrient deficiency or toxicity can reduce plant yield similar to a macronutrient deficiency or toxicity.

- Fertilizer use
  - **Ideal NPK (Nitrogen-Phosphorus-Potassium)** consumption ratio **- 4:2:1**
  - **Actual ratio** (2017-18) in India **- 6.1:2.4:1.**

B. Fertiliser Profile: India

- India is the **3rd largest producer** and **2nd largest consumer of fertilizers** in the world.
- The Indian fertilizer industry can broadly be **divided into two categories**, depending on the **nutrient composition:** (i) **nitrogenous fertilizers** and (ii) **phosphatic and potassic (P&K) fertilizers.**
  - **Nitrogenous Fertilizers –** Urea, calcium ammonium nitrate, ammonium chloride and ammonium sulphate etc.
  - **Phosphatic Fertiliser -** DAP (Di-Ammonium Phosphate), Mono Ammonium Phosphate (MAP), Triple Superphosphate (TSP) etc.
  - **Potash Fertiliser –** Murate of Potash (MOP) etc.

- Urea
  - Urea **dominates the Fertilizer sector** as a source of **Nitrogen.**
  - It is the most produced (86%), the most consumed (74%) and most imported (52%). India is 2nd largest consumer of **urea fertilizers** after China.
  - India meets **80% of urea requirements** via domestic production (20% imported).
  - Urea is the only fertilizer under **statutory price control** of the Government.

- Phosphatic fertilizers
  - DAP is the second majorly consumed fertilizer in India.

- **50% indigenous capacity** has been developed in respect of phosphatic fertilizers to meet domestic requirements. However, the raw-materials and intermediates for the same are largely imported.
- **Prices deregulated** by the Government.

- Potash Fertilizer
  - For **potash (K),** since there are **no viable sources/reserves in India**, its entire requirement **(100%)** is met through **imports.**
  - **Prices deregulated** by the Government.

C. Fertiliser Subsidy

- Fertilizer subsidy
  - 0.5% of GDP (2nd highest subsidy, after food subsidy).
  - But, only 35% of fertilizer subsidy reaches the intended beneficiaries (NITI Aayog).
- Urea Subsidy
  - Urea is sold at a Maximum Retail Price (MRP) **statutorily fixed by the Government of India**.
  - The difference between the delivered cost of fertilizers at farm gate and net market realization by the urea units is given as subsidy to the urea manufacturer/importer by the Government of India.
  - **FICC (Fertilizer Industry Coordination Committee**), an attached office under the Department of Fertilizers, calculates the Concession rate for indigenous urea as per **New Urea Policy** for existing units and **New Investment Policy (NIP) for new units**.

- Nutrient Based Subsidy (NBS)
  - The Nutrient Based Subsidy (NBS) Policy **for P&K fertilizers** has been implemented since 2010 by the **Department of Fertilizers.**
  - The MRPs of non-urea fertilisers are **decontrolled** by GoI (ie. fertilizer companies are free to fix the rates).
  - Under the NBS Policy, the Government announces a **fixed rate of subsidy (in Rs. per Kg basis**), on each nutrient of subsidized P&K fertilizers, namely Nitrogen (N), Phosphate (P), Potash (K) and Sulphur (S), on annual basis, taking into account all relevant factors including international prices, exchange rate, inventory level and prevailing Maximum Retail Prices of P&K fertilizers.

DBT FOR FERTILISER SUBSIDY

- From **March 2018**, a new **direct benefit transfer (DBT) system** was introduced, wherein subsidy payment to the companies would happen only after actual sales to farmers by retailers.
- Each retailer now has a point-of-sale (PoS) machine linked to the Department of Fertilisers' **e-Urvarak DBT portal.**
- Anyone buying subsidised fertilisers is required to furnish his/her Aadhaar unique identity or Kisan Credit Card number.
- Only upon the sale getting registered on the e-Urvarak platform can a company claim subsidy, with these being processed on a weekly basis and payments remitted electronically to its bank account.

PROMOTION OF CITY COMPOST

- The Department of Fertilizers notified the scheme for promotion of City Compost in 2016.
- Under the scheme, **Market Development Assistance (MDA)** in the form of fixed amount of Rs.1500/- per MT of City Compost will be provided for scaling up production and consumption of the product.

NEEM COATING OF UREA

- The Department of Fertilizer has made it mandatory for all the indigenous urea producers to **Neem Coat 100%** of their urea production, with the objective of promoting the **balanced use of fertilizers.**

- Benefits of Neem Coating of Urea
  - Preventing diversion towards non-agricultural purposes.
  - Due to slow release of Nitrogen, Nitrogen Use Efficiency (NUE) of Neem Coated Urea increases resulting in reduced consumption of NCU as compared to Normal urea.
  - Improvement in soil health.
  - Reduction in usage of plant protection chemicals.
  - Reduction in pest and disease attack.
  - An increase in yield of paddy, sugarcane, maize, soybean, Tur/Red Gram.

SOIL HEALTH CARD SCHEME

- Launched in 2015, it is a Centrally-sponsored nationwide scheme.
- It is a printed report card issued to farmers indicating the nutrient status of the soil.
- **Purpose:** The card carries crop-wise recommendations on appropriate dosage of fertilisers and other soil amendments to improve soil health and fertility.
- **Validity:** SHC is issued once in 2 years so that nutrient deficiency can be regularly detected & improved.
- SHC will contain the status of farmer's soil with respect to 12 parameters, namely N, P, K (Macro-nutrients); S (Secondary- nutrient); Zn, Fe, Cu, Mn, Bo (Micronutrients); and pH, Electrical Conductivity (EC), Organic Carbon (OC) (Physical parameters).

7.3 Irrigation

- Irrigation is main consumer of fresh water and more than **90% of groundwater** draft in India.
- Irrigation constitutes **70%** of total input cost.
- Currently, about **45%** of the agricultural area cultivating food grains is covered by irrigation. The rest of the area (55%) is dependent on rainfall (rain-fed agriculture).
- Rainfed agriculture contributes **40% of the agricultural output**.
- 50% of Total Rural Workforce & 60% of Livestock in Rainfed Areas.
- Sources of irrigation include
- **Ground water** - wells, tube-wells
- **Surface water** - canals, tanks
- Water use efficiency of Irrigation
- Agricultural sector, although consuming about 80% of India's water resources, suffers from **low water use efficiency of about 38%** (Developed countries – 50-60%).
- The predominantly used Conventional irrigation methods, such as **canal and flood irrigation**, have efficiency of **55%-65%** while the less utilized, improved **micro irrigation systems** using drip and micro irrigation technology have efficiency above **90%.**
- A huge amount of water loss in canal and flood irrigation occurs due to evaporation, percolation and seepage. (Closed pipe network reduces this loss significantly).
- **Low productivity per unit use of water -** India uses **2 – 4 times** more water to produce a unit of major food crop vis a vis China & Brazil. India a "**net water exporter".**

A. Micro Irrigation

- It is a modern method of irrigation in which water is irrigated through drippers, sprinklers, foggers and by other emitters on surface or subsurface of the land.
- **Drip irrigation** involves dripping water onto the soil at very low rates, close to plants so that only part of the soil in which the roots grow is wetted.
- **Sprinkler irrigation** is a method of applying irrigation water through a system of pipes usually by pumping. Water is sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground.

Benefits:

- **Precision** – Water directed towards roots and stems. Good scope for using it in closely spaced crops like rice, wheat, onion, potato etc.
- **Less Loss of Water** - due to evaporation & run off.
- **Prevents Diseases/Weed** caused by contact with water.
- **Prevents Overuse of Fertilizers** – Fertigation allows for better control of ground and surface water pollution and lower Fertilizer Costs.
- **Savings on Power** - Lower Electricity Costs.
- **Higher Farm Incomes -** Increase in crop productivity, better quality of produce leading to higher realization of sale price resulting in increased income of farmer, and prosperity.
- **Higher Yield** - water deficient, cultivable waste land and undulating land areas can easily be brought under cultivation due to ease of irrigation.

- **Challenges:**
- High initial investment.
- Lack of skills required for operation & maintenance.
- Poor and ineffective implementation of micro irrigation schemes.

IRRIGATION RELATED INITIATIVES

A) Pradhan Mantri Krishi Sinchai Yojna (PMKSY)

- **Aim:**
  - Ensuring access to water to every farm ("Har Khet Ko Pani").
  - Improving water use efficiency ("Per Drop More Crop").
- Aimed at covering the **remaining Rainfed Area** with irrigation.
- **Integrates 3 ongoing schemes**
  - **Accelerated Irrigation Benefit Programme (AIBP)** – Ministry of Jal Shakti
  - **Integrated Watershed Management Program** – Ministry of Rural Development
  - **On Farm Water Management** component of **National Mission on Sustainable Agriculture (NMSA)**– Ministry of Agriculture and Farmers Welfare
- **Objective:**
  - Convergence of investments in irrigation at the field level.
  - Enhance recharge of aquifers and introduce sustainable water conservation practices.
  - Explore the feasibility of reusing treated municipal waste water for peri-urban agriculture.
  - Attract greater private investments in irrigation.
  - Promote extension activities relating to water harvesting, water management and crop alignment for farmers and grass root level field functionaries.

Overseeing the implementation of the scheme: National Executive Committee (NEC) under the Chairmanship of the Vice Chairman, NITI Aayog.

Programme Components under PMKSY

1. **Accelerated Irrigation Benefits Programme (AIBP)**: under the **Ministry of Jal Shakti** focuses on faster completion of ongoing Major and Medium Irrigation including National Projects.
   - Its main features include Central Assistance (CA) and State Share through NABARD under **Long Term Irrigation Fund (LTIF).**
2. **Har Khet Ko Paani (HKKP)**: under the **Ministry of Jal Shakti** focuses on
   -Creation of new water sources through Minor Irrigation (both surface and ground water).
   - Repair, restoration and renovation of water bodies; strengthening carrying capacity of traditional water sources, construction rain water harvesting structures **(Jal Sanchay).**
   - Command area development, strengthening and creation of distribution network from source to the farm
   - Ground Water Development.
3. **Per Drop More Crop:** under the **Ministry of Agriculture** focuses on water

conveyance and precision water application devices like drips, sprinklers, pivots, rain-guns in the farm **(Jal Sinchan).**

4. Integrated Watershed Management Programme (IWMP): **under** Ministry of Rural Development **focuses**
   on development of rainfed portions of cultivated area and culturable wastelands. It focuses on management of runoff water and improved soil & moisture conservation activities through building water harvesting structures such as check dams, nala bund, farm ponds, tanks etc

Long Term Irrigation Fund (LTIF)

- LTIF was created in 2016-17 for funding and **fast tracking** the implementation of incomplete major and medium irrigation projects.
- It has been formed in NABARD, for funding identified ongoing projects under **PMKSY** (Pradhan Mantri Krishi Sinchayee Yojana).
- The loans are extended to State Governments at 6% per annum and the difference between the cost of fund for NABARD and 6% is compensated by Government of India through Interest Subvention.

Micro Irrigation Fund

- Micro Irrigation Fund with a corpus of Rs.5000 crore has been operationalized in NABARD.
- **Nodal Ministry -** Ministry of Agriculture and Farmers Welfare (MoA&FW)
- **Objective -** to facilitate State Governments efforts in mobilizing additional resources for expanding coverage under micro irrigation and incentivizing its adoption, **beyond the provisions of PMKSY**-Per Drop More Crop.

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8. Agriculture Credit

The Sources of agricultural credit can be broadly classified into

- **Institutional sources:** 72%
- **Non-institutional sources (relatives and moneylenders):** 28% (non-institutional sources were dominant in 1951, accounting for 90%).

A. Institutional Sources:

- **Commercial Banks:** Scheduled commercial banks contributed the **major share (78 – 80%)** in agricultural and allied credit.
- **Regional Rural Banks (RRBs) –** The RRBs aim at providing credit and other facilities to the small and marginal farmers, agricultural labourers, artisans and small entrepreneurs in rural areas.

Rural Co-operative Banks: three- tier system

- Primary Agricultural Credit Societies (PACS) at the village level
- Central or District Cooperative Banks (CCBs or DCCBs) at the district level
- State Cooperative Banks (StCBs) at the State level.

Micro Finance Institutions (MFIs): MFIs have evolved as a significant segment for the rural credit market exhibiting a variety of business models in recent years. As per Bharat Microfinance Report (2017), agriculture, animal husbandry and trading are major sub-sectors where income generating loans are deployed.

Land Development Banks - It includes State Co-operative Agriculture and Rural Development Banks **(SCARDBs)** and Primary Co-operative Agriculture and Rural Development Banks **(PCARDBs).** These provide both medium and long-term agri business loans against a collateral of land.

B. Non-Institutional Sources:

- Money Lenders, Traders and Commission agents, Relatives, Landlords etc.
- The interest rate of the non-institutional agri loans is usually very high, although the land or other assets are kept as collateral in the secured loans.

CREDIT RELATED INITIATIVES

A) Interest Subvention Scheme (IBS):

- Farmers can avail concessional crop loan upto Rs.3 lakhs at 7% rate of interest.
- This interest rate becomes 4% due to **3% interest subvention** incentives provided to those farmers who repay crop loan on time.
- **No requirement of collateral security** for farm loan up to Rs 1.6 lakh.

B) Kisan Credit Card

- Farmers can avail **short term loan** through Kisan Credit Card for cultivation of crops, post harvest expenses, consumption expenses of households, working capital for maintenance of farm assets, etc.
- Loan /credit limit is fixed on the basis of crop sown and area under cultivation. Kisan Credit Cards are valid for 3-5 years.
- Farmers are also provided risk coverage in the event of accidental death/ disability. Crop coverage loans are covered under the Crop Insurance Scheme.
- KCCs have now been converted into **Smart Card cum Debit Cards** to facilitate its operation through ATMs.

Benefits of KCC Scheme

- Provides **short term loans** to farmers at an interest rate of 4% on the condition of timely payment.
- The limit of the card can be increased for a loan up to Rs 3 lakh if KCC holder re-pays his/her due amount on time.
- **No collateral** is needed for a loan up to an amount of Rs 1.60 lakh. The banks will only charge simple interest on the loans.
- Apart from cheap credit, the crop of all farmers who have taken credit via KCC card will also be insured by the crop insurance scheme.
- The KCC account will also provide high interest to farmers on their savings in the account. Saving interest rate will be applied on their credit balance.

8.1 Agriculture Insurance

- The risks involved in farming are
  - **Production risk-** Weather, disease, pests, low yields, unpredictability of monsoon and changing climate.
  - **Market risk**- uncertainty about the prices producers will receive for commodities or the prices they must pay for inputs.
  - **Financial risk-** interest rates, availability of credit, loan repayment etc,
  - **Human resource risk-** death, disability, illness, labour availability etc.
- Crop insurance schemes are intended to **mitigate crop losses due to natural or manmade causes.**
- It is more effective way of helping farmers tide over unfavourable outcomes, besides reducing the financial burden on them.

A. Pradhan Mantri Fasal Bima Yojana (PMFBY)

- **Replaces existing agriculture insurance scheme** – NAIS (National Agriculture Insurance Scheme) and M- NAIS (Modified National Agriculture Insurance Scheme),
- **Objective** - To provide better insurance coverage for agricultural crops and thereby mitigate risk.
- Coverage

- **Crops**–All Notified crops
- Kharif, Rabi (Cereals, Millets, Pulses, Oilseeds), Commercial, Horticulture crops
- **Farmers–**
- including sharecroppers and tenant who have insurable interest in crops.
- Initially, it was compulsory for loanee farmers. However, **now it has been made voluntary** for all farmers, including loanee farmers.
- Maximum coverage for Women SC/ST/ women farmers.
- **Risks** – Covering risks at various stages of crop cultivation (Yield loss + damage)

✓ **Prevented sowing/planting risk** – insured area is prevented from sowing/planting due to deficient rainfall or adverse seasonal condition

✓ **Standing Crops–** against yield losses due to **non preventable risks -** drought, flood, pest, dry spells, Natural Fires lightening etc.

✓ **Post Harvest Losses–**against specific perils of **cyclonic** and **unseasonal rains**

✓ **Localized Risks** - occurrence of identified localized risks of hailstorm, landslide, and Inundation affecting isolated farms

- **Premium – lowest ever, uniform rate** (not based on actuarial ie. More risk more premium)

- Kharif Crops – 2% of sum insured
- Rabi crops – 1.5%
- Horticultural, Commercial Crops – 5%

Fixed premium

- Balance premium to be paid by Government → Centre – State share the subsidy burden equally.
- No cap on Premium subsidy → full coverage of insurance ie. Full insurance amount paid.
- **Use of Technology** – Mandatory Use of Remote sensing technology, smart phones, drones for quick crop loss assessment → will speed up the claim process.

No	Feature	NAIS [1999]	MNAIS [2010]	PM Crop Insurance Scheme
1	**Premium rate**	Low High		Lower than even NAIS (Govt to contribute 5 times that of farmer)
2	**One Season – One Premium** Yes No			Yes
3	**Insurance Amount cover** Full Capped			Full

4	**On Account Payment** No Yes			Yes
5	**Localised Risk coverage (Farm Level)**	No	Hail storm Land slide	Hail storm Land slide **Inund ation**
6	**Post Harvest Losses coverage** No		**Coastal areas** - for cyclonic rain	**All India** – for cyclonic + unseasonal rain
7	**Prevented Sowing coverage** No Yes			Yes
8	**Use of Technology** (for quicker settlement of claims)	No Intended		Mand atory
9	**Awareness**	No No		Yes (target to double coverage to 50%)

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9. Procurement Policy and Issues

FOOD PROCUREMENT POLICY IN INDIA

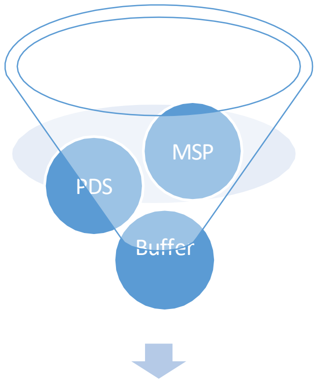
- Objectives

\- Procurement of food grains from farmers at remunerative prices → **Minimum Support Price (MSP).**

\- Distribution of food grains to the consumers, particularly the vulnerable sections of the society, at affordable prices

→ Public Distribution System (PDS).

\- Maintenance of food buffers for food security and price stability → **Buffer Stock.**



Food Procurement Policy

9.1 Minimum Support Price (MSP)

A. Meaning

- MSP is a form of market intervention by Central Government to **insure agricultural producers** against any sharp fall in farm prices, by guaranteeing minimum prices for their produce.
- Major objectives of MSP**:**
- To support the farmers and prevent them from distress sales.
- To procure food grains for public distribution.
- MSP is announced by the Government at the beginning of the sowing season for certain crops on the basis of the recommendations of the **Commission for Agricultural Costs and Prices** (CACP)
- The MSPs recommended by the CACP are finally approved by **Cabinet Committee on Economic Affairs** (chaired by the Prime Minister).
- **Crops covered:**

CACP recommends MSPs of 25 commodities			
CEREALS (7)	**PULSES (5)**	**OILSEEDS (8)**	**COMMERCIAL CROPS (5)**
▪ Paddy ▪ Jowar ▪ Bajra ▪ Maize ▪ Ragi ▪ Wheat ▪ Barley	▪ Arhar ▪ Moong ▪ Urad ▪ Gram ▪ Masur (lentil)	▪ Groundnut ▪ Soyabean ▪ Sunflower ▪ Sesamum ▪ Nigerseed ▪ Rapeseed/Mustard ▪ Safflower ▪ Toria	▪ Copra ▪ Coconut ▪ Sugarcane (Fair & remunerative prices) ▪ Cotton ▪ Raw jute

A. Commission for Agricultural Costs and Prices (CACP)

- CACP is an attached office of the **Ministry of Agriculture and Farmers Welfare.**
- It came into existence in January 1965.
- It is mandated to **recommend MSP** to the Central government in form of annual Price Policy Reports.
- In making its recommendations, it takes into account **factors like**: cost of production, changes in input prices, trends in market prices, demand and supply, effect on cost of living, effect on general price level, international price situation etc.
- Current Composition of CACP
  - The Commission comprises a Chairman, Member Secretary, one Member (Official) and two Members (Non-Official).
  - The non-official members are representatives of the **farming community** and usually have an active association with the farming community.

B. Current MSP & Procurement Mechanism: Challenges

- **Restricted to a few crops –** While the Government announces MSP for 25 crops, the official procurement at the MSP is disproportionately focused on wheat, rice and sugarcane, which has led to:
  - Imbalanced cropping pattern at the expense of other crops such as pulses, oilseed &

coarse grains.

- Depletion of water resources, soil degradation and persistence of monocultures due to focus on input intensive crops (wheat, rice & sugarcane).
- Distortion of rational/sustainable farm practices as farmers tend to grow more remunerative wheat and rice, irrespective of their agro climatic suitability.

• **Regional imbalance –** Public procurement mainly confined to few states (eg. Punjab, Haryana, Maharashtra, U.P., A.P etc.) and very few farmers **impacts inclusive growth.**

• Fueling inflation

- Poor price realization in market + Rising MSPs + open ended procurement by FCI Increase in buffer stocks of foodgrains above the required norms & decrease in the supply in the open market diversion of foodgrains from consumption to storage inflation.
- MSP forms a **'floor'** for market prices of crops. A persistent increase in MSP pushes up prices in the market, adversely impacting consumers, including farmers.
- MSP's exclusive focus on a few crops reduces the supply of other foodgrains (eg. pulses, oilseeds etc), thereby inducing inflation.

• **Impact on Fiscal Marksmanship –** Rapidly expanding **food subsidy bill** due to rising MSP, foodgrain storage, handling & carrying costs, thus, exerting pressure on fiscal deficit.

• **Lack of awareness among farmers -** Even for paddy and wheat, where active procurement occurs, less than 50% farmers have reported awareness of MSP.

CENTRALIZED PROCUREMENT SYSTEM

- Under Centralized Procurement System, the procurement of foodgrains in Central Pool are undertaken **either by Food Corporation of India (FCI) directly** or State Government agencies procures the foodgrains and handover the stocks to FCI for storage and subsequent issue against GOI allocations in the same State or movement of surplus stocks to other States.

- The cost of the foodgrains procured by State agencies is **reimbursed by FCI** as soon as the stocks are delivered to FCI.

DECENTRALIZED PROCUREMENT SYSTEM (DCP)

- The scheme of Decentralized Procurement of foodgrains was introduced by the Government in 1997-98 with a view to **enhancing the efficiency of procurement** and PDS and encouraging local procurement to the maximum extent, thereby extending the benefits of MSP to local farmers, as well as to save on transit costs.
- This also enables procurement of foodgrains more **suited to the local taste.**
- Under this scheme, the **State Government itself undertakes direct purchase** of paddy/rice and wheat and also stores and distributes these foodgrains under National Food Security Act (NFSA) and other welfare schemes.
- The Central Government undertakes to meet the entire expenditure incurred by the State Governments on the procurement operations as per the approved costing.

C. "Pradhan Mantri Annadata Aay SanraksHan Abhiyan" (PM-AASHA)

• The scheme aims to ensure a **robust procurement mechanism,** in coordination with the State Governments, such that an increase in MSP will be translated to higher farmer's income.

- The AASHA scheme has three components:

1. Price Support Scheme (PSS)
- Under PSS, **physical procurement** of pulses, oilseeds and Copra will be done by Central Nodal Agencies like NAFED and Food Cooperation of India (FCI), at the MSP declared by the government.
- Procurement under PSS is continued till prices stabilize at or above the MSP.
- **Losses**, if any, incurred in undertaking MSP operations are reimbursed by the Central Government.
- **Profit**, if any, earned in undertaking MSP operations is credited to the Central government.
- This scheme is implemented at the request of the concerned **State Government** which agrees to exempt the procured commodities from levy of mandi tax and assist central nodal agencies in logistic arrangements.

2. Price Deficiency Payment Scheme (PDPS)
- Under this, the Centre proposes to cover all **oilseeds** and pay the farmer **directly** into his bank account the difference between the MSP and his actual selling/modal price.
- Pre – registered farmers who sell their crops in recognised mandis within the notified period can benefit from it.

This scheme **does not** involve any **physical procurement** of crops.

3. Pilot of Private Procurement & Stockist Scheme (PPSS).
- In the case of oilseeds, States will have the option to roll out PPSSs in select districts where a private player can procure crops at MSP when market prices drop below MSP.
- The private player will then be compensated through a service charge that will be up to a maximum of 15 per cent of the MSP of the crop.
- It involves **physical procurement** of the notified commodity.

- The AASHA scheme will be **complementing the existing schemes** of the Department of Food and Public Distribution for procurement of paddy, wheat and other cereals and coarse grains where procurement takes place at MSP.

NATIONAL AGRICULTURAL COOPERATIVE MARKETING FEDERATION OF INDIA LTD (NAFED)

- **Established in** 1958 and registered under the **Multi State Co-operative Societies Act**, 2002
- **Aim** - to promote Co-operative marketing of Agricultural Produce to benefit the farmers.
- **Members** - Agricultural farmers are the main members of NAFED who have the say, as members of the General Body, in the working of NAFED.
- NAFED is **one of the central Nodal Agencies** for procurement of notified agricultural commodities of **Oilseeds**, **Pulses** and **Cotton** under Price Support Scheme (PSS).
- It is the **sole central Nodal Agency** for procurement of Milling, Ball Copra and De-husk Copra under Price Support Scheme.

D. Market Intervention Scheme (MIS)

- It is for procurement of agricultural and horticultural commodities which are **perishable in nature** and are **not** covered under the Price Support Scheme (PSS)
- The scheme is implemented at the request of a State/UT Government which is ready to bear 50% of the loss (25% in case of NE States), if any, incurred on its implementation.
- The extent of **total amount of loss** to be shared (between Centre & State) is restricted to 25% of the total procurement value which includes cost of the commodity procured plus permitted overhead expenses.

BUFFER STOCK

- Objectives
  - Providing food grains under public distribution system.
  - or meeting natural calamities.
  - Price stabilization in case of crop failures and shortfall in production.

- **FCI (Food Corporation of India)** has the prime responsibility of procuring the food grains
  - These food grains are procured at MSP.
  - FCI also sells in the open market to stabilize the prices esp. in case of crop failures.
  - **Issue:** Current buffer stocks hover almost double the prescribed limit.
  - **Cause:** Govt. is mandatorily required to procure whatever comes to FCI. Farmers prefer to sell to FCI because:
  - ✓ MSP is generally higher than market price and
  - ✓ FCI procures in bulk.
  - **Impact:** It leads to an estimated loss of Rs. 50,000 crore on account of increased Transportation costs, Storage costs, Transit losses, Deterioration of quality due to inefficient storage etc.
  - **Solution:** "**Price Deficiency Payment**" (as recommended by NITI Action Agenda).
  - ✓ While MSP may still be used for need-based procurement, under the deficiency payments system, a subsidy would be provided on other targeted produce in case the price falls below an MSP-linked threshold. This approach would not require procurement and thereby prevent accumulation of unwanted stocks.

CENTRAL ISSUE PRICE (CIP)

- Wheat and rice are sold by the central government at uniform **central issues prices (CIP)** to states and union territories for distribution under **Targeted PDS (TPDS).**
- **Central Issue Price under NFSA:** Foodgrains under National Food Security Act (NFSA) are made available at subsidized prices of Rs.3/2/1 per kg for rice, wheat and coarse grains respectively.
- The CIP of wheat and rice for NFSA beneficiaries has not been revised since the introduction of the Act in 2013. But through these years, the **MSP has been increasing**.

- The difference between the MSP (higher than market price) and the lower CIP has led to increasing **food subsidy per kg of food grain.**
- Thus, the total **food subsidy bill** of the centre govt. is increasing, estimated to be **Rs. 1.1 lakh crore in 2020-21.**

Food Subsidy = **Economic Cost – Central Issue Price (CIP)**

Economic Cost	Central Issue Price	(CIP)
↓	↓	↓
Increasing	**Increasing**	**Stagnant**

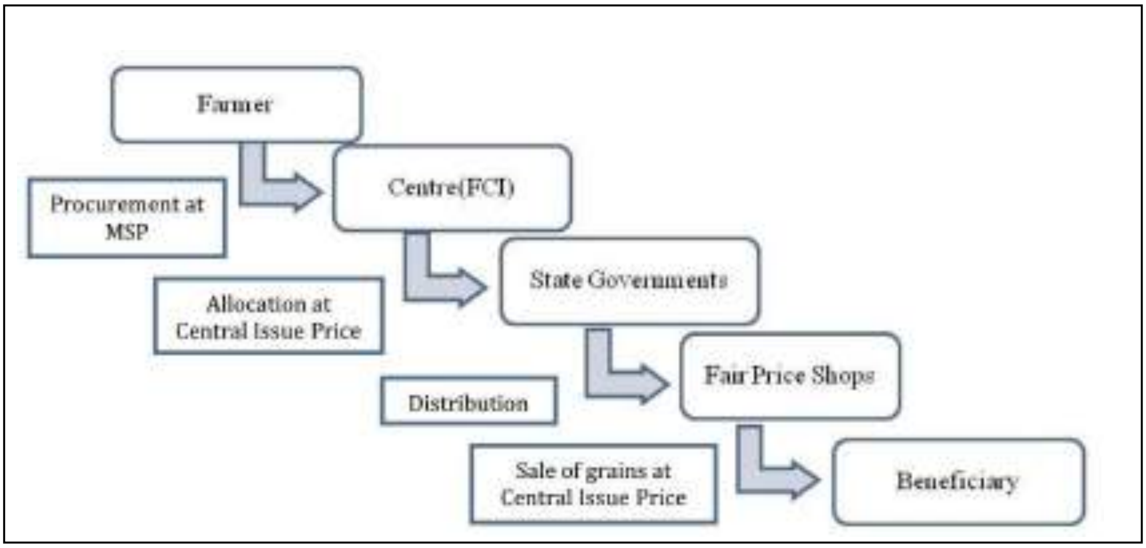
Economic Cost = Actual Cost borne by FCI from Time of Procurement Till Distribution

1. Procurement Cost (MSP) ➔ increasing
2. Procurement Incidentals (Mandi Tax, Storage, Transport) ➔ inefficient procurement/Storage methods
3. Cost of Distribution ➔ inefficient distribution

9.2 Public Distribution System (PDS)

- Public distribution system is a **government-sponsored chain of shops** entrusted with the work of distributing **basic food and non-food commodities** to the needy sections of society at very cheap prices.
- PDS is operated under the **joint responsibility** of the Central and the State Governments.
- The **Central Government, through Food Corporation of India (FCI),** has the responsibility for procurement, storage, transportation and bulk allocation of food grains to the state governments.

Under the PDS, the commodities like wheat, rice, sugar and kerosene are being allocated to the States/UTs for distribution. Some States/UTs also distribute additional items of mass consumption through the PDS outlets such as pulses, edible oils, iodized salt, spices, etc.



EVOLUTION OF PDS SYSTEM IN INDIA

- **Early Public Distribution System**
  - Was a general entitlement for all the citizens.
  - A fixed amount of food grains, sugar and edible oil were distributed through dedicated govt. outlets called Fair Price Shops (FPS),
  - At a price lower than the market rate.
- **Revamped PDS**
  - Was launched in 1992 in 1775 blocks (mostly backward and remote areas).
  - To focus PDS towards economically backward families.
- **Targeted PDS**
  - Was launched in 1997
  - Under TPDS, beneficiaries were divided into two categories
    - ✓ Households below the poverty line or BPL
    - ✓ Households above the poverty line or APL
- **Antyodaya Anna Yojana (AAY)**
  - The scheme was launched in December 2000 for the poorest among the BPL families.
  - These families get 35 kg of food grains: Rs. 3/kg Rice and Rs. 2/kg wheat.

NATIONAL FOOD SECURITY ACT, 2013

- **Coverage** – Approx. 67% of India's population with 75% in rural areas and 50% in urban areas.
- **Entitlement** � "Legally guaranteed" (Right based approach)
  - Uniform entitlement of 5 kg per person per month.
  - Entitlement of **AAY beneficiaries** protected at 35 kg of food grains per family.
- **Subsidized foodgrains** - Rs. 3/2/1 per kg for rice, wheat and coarse grains.
- **Nutritional Support to women and children**
  - Pregnant women and lactating mothers (under ICDS).
  - Children in the age group of 6 months to 14 years (under Mid Day Meal).
  - Higher nutritional norms prescribed for malnourished children upto 6 years of age.
- **Transparency & Accountability** - disclosure of records relating to PDS, social audits & setting up of Vigilance Committees.

Table 16: Comparison of existing TPDS with the National Food Security Act

Provision	Current TPDS	National Food Security Act 2013
Implication for 'right to food'	Set up under administrative order; no legal backing	Provides statutory backing for right to food
Coverage	90.2 crore beneficiaries = 18.04 crore families x 5 (average no. of members in a family)	Up to 75% of rural and up to 50% of urban population, about 81.34 crore beneficiaries[32]
Categories	AAY, BPL, and APL	AAY, priority, and excluded
Entitlements per category	BPL and AAY: 35 kg/family/month APL: 15 – 35 kg/family/month	Priority: 5 kg/person/month AAY: 35 kg/family/month
Prices of food- grains	AAY: Rs 3/kg for rice, Rs 2/kg for wheat, and Re 1/kg for coarse grains Other categories: differs across states	All categories: Rs 3/kg for rice, Rs 2/kg for wheat, and Re 1/kg for coarse grains
Identification of beneficiaries	Centre: ▪ releases state-wise estimates of population to be covered under TPDS ▪ creates criteria for identification States: Identify eligible households	Centre: releases state-wise estimates of population to be covered under Act States: ▪ create criteria for identification ▪ identify eligible households
Centre-state responsibility	Centre: procurement; state-wise allocation; transport of grains up to state depots; storage States: delivery of grains from state depots to ration shop to beneficiary	Same as current system with some additions Centre: provides food security allowance to states to pass on to beneficiaries Centre and states: not responsible for failure to supply food grains during force majeure conditions, e.g., war, flood, drought
Grievance redressal mechanism	State governments responsible for ensuring monitoring; vigilance committees to be set up at state, district, block and ration shop levels	Appoints district grievance redressal officers; establishes State Food Commissions; and vigilance committees at state, district, block and ration shop levels

Sources: PDS (Control) Order, 2001; National Food Security Act, 2013; PRS.

PDS vs. Cash Transfers – a comparison

Table 15: Advantages and disadvantages of PDS and other delivery mechanisms[31]

Mechanism	Advantages	Disadvantages
PDS	Insulates beneficiaries from inflation and price volatility Ensures entitlement is used for food grains only Well-developed network of FPS ensures access to food grains even in remote areas	Low offtake of food grains from each household High leakage and diversion of subsidised food grain Adulteration of food grain Lack of viability of FPS due to low margins
Cash transfers	Cash in the hands of poor increases their choices Cash may relieve financial constraints faced by the poor, make it possible to form thrift societies and access credit Administrative costs of cash transfer programmes may be significantly lesser than that of other schemes Potential for making electronic transfer	Cash can be used to buy non-food items May expose recipients to price volatility and inflation There is poor access to banks and post offices in some areas
Food coupons	Household is given the freedom to choose where it buys food Increases incentive for competitive prices and assured quality of food grains among PDS stores Ration shops get full price for food grains from the poor; no incentive to turn the poor away	Food coupons are not indexed for inflation; may expose recipients to inflation Difficult to administer; there have known to be delays in issuing food coupons and reimbursing shops

Sources: See Endnote 31; PRS.

Table 14: Technology-based reforms to TPDS undertaken by some states

Type of reform	Benefits of reform	States implementing reforms
Digitisation of ration cards	▪ Allows for online entry and verification of beneficiary data ▪ Online storing of monthly entitlement of beneficiaries, number of dependants, offtake of food grains by beneficiaries from FPS, etc.	Andhra Pradesh, Chhattisgarh, Tamil Nadu, Madhya Pradesh, Karnataka, Gujarat, etc.
Computerised allocation to FPS	▪ Computerises FPS allocation, declaration of stock balance, web-based truck challans, etc. ▪ Allows for quick and efficient tracking of transactions	Chhattisgarh, Delhi, Madhya Pradesh, Tamil Nadu, etc.
Issue of smart cards in place of ration cards	▪ Secure electronic devices used to store beneficiary data ▪ Stores data such as name, address, biometrics, BPL/APL category and monthly entitlement of beneficiaries and family members ▪ Prevents counterfeiting	Haryana, Andhra Pradesh, Orissa, etc.
Use of GPS technology	▪ Use of Global Positioning System (GPS) technology to track movement of trucks carrying food grains from state depots to FPS	Chhattisgarh, Tamil Nadu
SMS based monitoring	▪ Allows monitoring by citizens so they can register their mobile numbers and send/receive SMS alerts during dispatch and arrival of TPDS commodities	Chhattisgarh, Uttar Pradesh, Tamil Nadu
Use of web-based citizens' portal	▪ Publicises grievance redressal machinery, such as toll free number for call centres to register complaints or suggestions	Chhattisgarh

Sources: Justice Wadhwa Committee Report on Computerisation of PDS Operations, 2009; PRS.

Case study: Chhattisgarh Food Security Act

On December 1, 2012, the Chhattisgarh Assembly passed the Chhattisgarh Food Security Act, 2012, preceding the National Food Security Act. The Act provides statutory backing to TPDS and the reforms implemented by the state to improve TPDS. Key features of the Act are:[24]

Provision	Detail
Beneficiaries	AAY, priority and general households; state government shall prescribe guidelines for their identification including guidelines for excluded households
Entitlements/month	AAY and priority households - 35 kg of food grain, 2 kg each of iodised salt, black gram and pulses (subsidised) General households - 15 kg of food grains (subsidised)
Special groups	Pregnant women and lactating mothers, children up to 14 years, students in hostels and ashrams, destitute, homeless, migrants, emergency or disaster affected persons
Implementing authorities	Local authorities shall be responsible for: (i) identification of eligible households, (ii) issuing ration cards, (iii) monitoring and supervision of fair price shops, and (iv) conducting social audits of fair price shops.
Grievance Redressal Mechanism	Internal mechanism including call centres, nodal officers, etc. Provision of entitlements to eligible households shall be notified as services to be provided under the Chhattisgarh Public Service Guarantee Act, 2011
Reforms to TPDS	Includes doorstep delivery of grains to ration shops, leveraging Aadhaar for targeting of beneficiaries, and maintenance of adequate buffer stocks of food items
Force Majeure	The state government shall not be held liable for a lack of supply due to war, flood, drought, fire, etc

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10. Agriculture Marketing

10.1 Agricultural Produce Market Committee (APMC)

- Agricultural Produce Market Committee (APMC) is a **statutory market committee** constituted by a **State Government** in respect of trade in certain notified agricultural or horticultural or livestock products, under the **Agricultural Produce Market Committee Act** issued by that state government.
- Functions of APMCs:
  - Ensuring Transparency in pricing system and transactions taking place in market area.
  - Providing market-led extension services to farmers.
  - Ensuring payment for agricultural produce sold by farmers on the same day.
  - Promoting agricultural processing including activities for value addition in agricultural produce.
  - Publicizing data on arrivals and rates of agricultural produce brought into the market area for sale.
  - Setting up and promoting public private partnership in the management of agricultural markets.
- Typical amenities available in or around the APMCs are**:**
  - Auction halls, weigh bridges, godowns, shops for retailers, canteens, roads, lights, drinking water, police station, post-office, bore-wells, warehouse, farmers amenity center, tanks, Water Treatment plant, soil-testing Laboratory, toilet blocks, etc.

10.2 Agricultural Marketing in India: Challenges

- **Fragmentation of markets** - for eg. Thousands of APMC markets under respective State Government, with no linkages between them, operating in monopolistic silos.
- Lack of unrestricted movement
  - Obsolete APMC act mandates that **farmer's first sale** shall only be to commission agents, which forces farmers to sell their produce in the **immediate** market yards.
  - This creates problem of plenty at one market and scarcity at another market, resulting either in price-depression and loss to producer, or inflation and loss to the consumer
- **Less farmers' price realisation** - The share of farmer in consumer's price is very low, particularly in perishables, due to a large number of intermediaries, lack of infrastructure and poor holding capacity

- **Discourages Direct selling** - No direct selling to contract farming sponsors, retailers, food processing unit etc. As a result, farmers are unable to command higher profits, forward linkages to food processing industry are distorted, and private investment is adversely affected
- **Exploitation by intermediaries** - Lack of direct selling opportunity also increases exploitation by commission agents, who cartelise themselves, depress gains of farmer,

increase prices of consumer, restrict entry of new players, etc.

- **High Incidence of Market Charges** - Multiplicity of market levies, taxes, commissions, and fees at the first level of trading has cascading effect on retail prices, thus, causing inflation.
- **Non transparency in utilization of levies collected** – Levies do not go to state exchequer and, hence, do not require approval of state legislature. No oversight on its utilization.
- **Political interference & corruption** - APMC and APMC boards are occupied by politically influential persons, who are hand in glove with commission agents to wield monopoly power over a particular market area
- **High Wastages in Supply Chain** - Inclusion of fruits and vegetables under the purview of APMCs has resulted in Post-harvest losses & large wastage
- **Lack of Infrastructure in Agricultural Markets** - No major investment in modern infrastructure such as cold storage, modern warehouses, Electronic weigh-bridges etc
- **High marketing cost** – That particularly affects small and marginal farmers who have small marketable surplus impacts actual price realisation.

10.3 Recent Agricultural Reform Acts

A. The Farmers' Produce Trade and Commerce (Promotion and Facilitation) Act, 2020

- The Act allows **intra-state and inter-state** trade of farmers' produce beyond the physical premises of states' APMC markets, notified under the various state **APMC Acts.**

- The Act will prevail over the APMC Acts in the area outside such markets.

- **No fees to be levied by states:** The Act prohibits the state governments and APMCs from levying any market fee, cess, or any other charge on the trade of scheduled farmers' produce outside the APMC notified markets.
- **Electronic trading platforms:** The Act provides for setting up of electronic trading platforms to facilitate

direct and online buying and selling of farmers' produce, resulting in physical delivery of the produce.

- **Three-level dispute settlement mechanism:** In case of disputes arising between a farmer and a trader, the parties involved in the dispute may apply to the **Sub-Divisional Magistrate (SDM)** for relief through conciliation.
- **Significance of the act:** The new legislation will create an ecosystem where the farmers and traders will enjoy the freedom of choice of sale and purchase of agri-produce.

B. The Farmers (Empowerment and Protection) Agreement On Price Assurance and Farm Services Act, 2020

- The Act focuses on creating avenues for farmers to **engage in contract farming.**
- **Farming agreement**: The Act provides for a farming agreement prior to the production or rearing of any farm produce, facilitating farmers in selling farm produce to sponsors.
- **Pricing of farming produces:** The price to be paid for the purchase of farming

produce should be mentioned in the agreement. In case the price is subject to variation, the agreement must include:

1. **A guaranteed price** to be paid for such produce.
2. A clear price reference for any additional amount over and above the guaranteed price.

- **Dispute Settlement:** Act requires a farming agreement to provide for a conciliation board (comprising of representatives of parties to the agreement) and a conciliation process for settlement of disputes.

C. The Essential Commodities (Amendment) Act, 2020

- The Act regulates the supply of certain food items, including cereals, pulses, potatoes, and onions, **only under extraordinary circumstances** such as war, famine, extraordinary price rise, and natural calamity of grave nature.
- A stock limit may be imposed on agricultural produce **only if** there is:
  - A 100% increase in the retail price in case of horticultural produce, or
  - A 50% increase in the retail price in the case of non-perishable agricultural food items.
- Also, processors and value chain participants are **exempted from the stock limit**.
- **Benefits** – Increased investment in cold chain infrastructure and development of food processing industry better prices to farmers & reduced wastage.

OTHER KEY INITIATIVES FOR REFORMS IN AGRICULTURE MARKETING

- Launch of **e- NAM**, a pan India electronic platform to create a **National Agricultural Market**. Recent initiatives:
  - Integration of Negotiable Warehouse Receipt System **(e-NWRs)** Module with e-NAM.
  - **Farmer Producers' Organisations (FPOs) Portal** – FPO can upload a picture of their produce and quality parameters from their premise to enable distant bidders to visualise the produce before bidding.
  - **Logistic Module** - Linking large logistic aggregator platforms with e-NAM, thus, providing choices to users (Traders) and help in seamless transportation of agri-produce.
- Launch of an e-marketing portal for **Organic Products.**
- Measures to popularise the **pledge loan** and **e-NWR** based marketing.
- State governments have been advised to **exempt fruits and vegetables** from the purview of APMC act.
- **SAMPADA** (Scheme for Agro-Marine Processing and Development of Agro-Processing Clusters) – For creation of modern infrastructure with efficient supply chain management from farm gate to retail outlet, including setting up of new mega food parks (MFP).
- **Operation Greens** - To address price fluctuations in tomato, onion, & potato (TOP). **'TOP to TOTAL'** extends Operation Greens to all fruits & vegetables for a defined period, under Atmanirbhar Bharat Package.
- Developing & upgrading existing 22,000 rural haats into **Gramin Agricultural Markets (GrAMs).** GrAMs to be **electronically linked to e-NAM** and exempted from regulations of APMCs, thus, enabling farmers to make direct sale to consumers & bulk purchasers.
- Setting up of Agriculture Funds to boost market infrastructure
  - **Agriculture Infrastructure Fund** of Rs. 1 lakh crore for building post-harvest storage and processing facilities, including development of warehouses, cold storage, pack houses and marketing facilities in the rural areas.
  - **Agri-Market Infrastructure Fund** with a corpus of Rs.2000 crore for developing and upgrading agricultural marketing infrastructure in the GrAMs and APMCs.
- NITI Aayog's '**Agriculture Marketing and Farmer Friendly Reforms Index'** to sensitise states about the need to undertake reforms in 3 key areas of Agriculture Market Reforms, Land Lease Reforms and Forestry on Private Land.
- Central Sector Scheme titled "**Formation and Promotion of Farmer Producer Organizations (FPOs)**" to form and promote 10,000 new FPOs by 2023-24.

10.4 Other Govt. Initiatives

NATIONAL MISSION FOR SUSTAINABLE AGRICULTURE (NMSA)

- Launched in 2014-15, as a programme under **National Action Plan on Climate Change** (NAPCC) (initiated in 2010).
- **Objective -** To transform Indian agriculture into a **climate resilient production system** through suitable adaptation and mitigation measures mainly in the domain of crops and animal husbandry.
- **Activities –** It aims at promoting **location specific improved agronomic practices** through soil health management, enhanced water use efficiency, judicious use of chemicals, crop diversification, progressive adoption of crop-livestock farming systems and integrated approaches like crop-sericulture, agro-forestry, fish farming, etc.

NMSA: KEY COMPONENTS

- **Rainfed Area Development (RAD)**

  - It adopts an **area based approach** for development and conservation of natural resources along with farming systems.
  - **Integrated Farming System (IFS) -** crops/cropping system is integrated with activities like horticulture, livestock, fishery, agro-forestry, apiculture
  - Formulated in a **'watershed plus framework'**, i.e., to explore potential utilization of natural resources base/assets created through watershed development and soil conservation activities under MGNREGS, NWDPRA (National Watershed Development Project for Rainfed Areas), RKVY (Rashtriya Krishi Vikas Yojana), IWMP (Integrated Watershed Management Programme) etc.

- **Soil Health Management (SHM) –** Aims at promoting location as well as crop specific sustainable soil health management. Includes initiatives like **Soil Health Card** and **Paramparagat Krishi Vikas Yojna.**

- **Sub-Mission on Agroforestry (SMAF)** - Launched in 2016-17 to encourage tree plantation on farm land "***Har Medh Par Ped***", along with crops/ cropping system and livestock to improve productivity, employment opportunities, income generation and livelihoods of rural households especially the small farmers
- **Climate Change and Sustainable Agriculture: Monitoring, Modeling and Networking (CCSAMMN)** - Provides creation and bidirectional (land/farmers to research/scientific establishments and vice versa) dissemination of climate change related information and knowledge by way of piloting climate change adaptation/mitigation research/model projects.

- **National Bamboo Mission (NBM)**

- **NBM Launched in –** 2006-07, **Restructured Mission -** Approved in 2018-19.
- Objective **–**

✓ To **promote holistic growth** of bamboo sector by adopting area-based, regionally differentiated strategy.

✓ To **increase the area** under bamboo plantation in **non-forest Government** and **private lands** to supplement farm income, increase availability of quality raw material requirement of industries, and contribute towards resilience to climate change.

✓ To **improve post-harvest management** by establishing innovative primary processing units (near the source of production), preservation technologies and market infrastructure.

✓ To **promote product development** keeping in view market demand, by assisting R&D, entrepreneurship & business models at micro, small and medium levels and feed bigger industry.

✓ To promote skill development, capacity building, awareness generation for development of bamboo sector from production to market demand.

✓ To rejuvenate the under developed bamboo industry in India and realign efforts so as to reduce dependency on import of bamboo and bamboo products.

PARAMPARAGAT KRISHI VIKAS YOJNA

- Sub component of National Mission on Sustainable Agriculture (NMSA).
- **Aim** – to promote **organic farming** and reduce reliance on chemical fertilizers.
- **Approach** - Cluster based organising farmers in groups of 50 or more, having total holdings of 50 acres to take up organic farming.
- **Financial Assistance -** Every farmer will be provided Rs. 50,000 per hectare in three years for cluster formation, capacity building, incentive for inputs, value addition and marketing.
- Organic products will be linked with the market.
- No liability on the farmers for expenditure on certification of organic manure.
- **Organic Value Chain Development for North Eastern region -** A special scheme has also been launched in **North-Eastern Region** for promotion of organic farming and export of organic produce.

NATIONAL LIVESTOCK MISSION

- **Launched:** 2014-15
- **Objective:** Sustainable development of livestock sector, focusing on improving availability of quality feed and fodder.
- **Coverage:** all the activities required to ensure quantitative and qualitative improvement in livestock production systems and capacity building of all stakeholders
- 4 Sub-missions **–**

1. **Fodder and Feed development** – To address the problems of scarcity of animal feed resources, and eliminate deficit.
2. **Livestock Development** - productivity enhancement, entrepreneurship

development and employment generation, strengthening/ modernization/automation of infrastructure of state farms, conservation of threatened breeds, livestock insurance etc.

3. **Pig development in North-Eastern Region** - all round development of piggery in the region.

4. **Skill Development, Technology Transfer and Extension –** to help farmers adopt the technologies developed by research institutions.

RASHTRIYA GOKUL MISSION

- Launched in 2014
- **Objective:**
  - Development, preservation and conservation of **indigenous** Bovine breeds "in a focused and scientific manner"
  - To enhance milk production and productivity of indigenous bovines.
  - Interventions under RGM
  - Setting up of integrated cattle centres - **Gokul Grams**
  - Establishment of breeders societies – **Gopalan Sangh**
  - Award to Farmers **– Gopal Ratna** & Award to breeders societies – **"Kamdhenu"**
- **Target beneficiaries –** Rural cattle and buffalo keepers irrespective of caste, class and gender.

Gokul Grams: Integrated Indigenous Cattle Centres

- **To be established in:** native breeding tracts and near metropolitan cities for urban cattle.
- **Setup:** independently or through PPP.
- **Milch & unproductive animals:** to be maintained in ratio of 60:40.
- **Regular screening:** for diseases like brucellosis and tuberculosis.
- **Self-sustaining**: will generate economic resources from sale of A2 milk, organic manure, vermi-composting, urine distillates, and production of electricity from bio gas.

RGM: 2 SUB COMPONENTS

- **National Programme for Bovine Breeding**
  - Focuses on extension of field level Artificial Insemination (AI) network through **MAITRI.**
  - **MAITRI** - Multi Purpose Artificial Insemination Technicians to provide AI services& and breeding inputs at Farmer's Doorstep)
- **National Mission on Bovine Productivity**
  - **Objective –** Enhance milk production and thereby make dairying more remunerative to farmers.
  - **Key components**
    - ✓ **Pashu Sanjivni**– It is an Animal Wellness Programme; encompassing setting up of Emergency Help Lines, provision of Animal Health cards **('Nakul Swasthya Patra'**) along with UID identification and a **National Data Base** (INAPH).
    - ✓ **E-PashuHaat portal -** To connect farmers and breeder (State, Central, Co-operative, Milk Federations, and private agencies) of indigenous breeds regarding availability of bovine germplasm. It provides real time authentic certified information on availability of germplasm.

PRADHAN MANTRI MATSYA SAMPADA YOJANA (PMMSY)

- The Prime Minister launched the Rs 20,050 crore-**Pradhan Mantri Matsya Sampada Yojana** (PMMSY), as a part of the **Aatmanirbhar Bharat Abhiyan.**
- It is the **flagship scheme** to bring about **Blue Revolution** through sustainable and responsible development of fisheries sector in India.
- Key Targets –
  - **Enhancing fish production** by an additional 70 lakh tonne by 2024-25 to 220 lakh metric tons at an average annual growth rate of about **9%.**
  - **Increasing fisheries export earnings** to Rs. 1 lakh crore by 2024-25.
  - **Doubling of incomes** of fishers and fish farmers.
  - **Reducing post-harvest losses** from 20-25% to about 10%.
  - **Generation of additional employment** - 55 lakhs direct and indirect gainful employment opportunities in fisheries sector and allied activities.
  - **Investment -** Rs. 20,050 crores. It is the **highest ever** in the fisheries sector with focus on:
  - Beneficiary-oriented activities in Marine, Inland fisheries and Aquaculture
  - Fisheries Infrastructure – 42% of investment

- **Implementation period** - 5 years from FY 2020-21 to FY 2024- 25 in all States/Union Territories.

- Implementation strategy
  - Adopting '**Cluster or Area based approaches'** and creation of Fisheries clusters through backward and forward linkages.
  - Special focus on employment generation activities such as **seaweed & ornamental fish cultivation**.
  - **Consolidating gains of Blue Revolution & New interventions** (***Swath Sagar*** **plan**) such as fishing vessel insurance, support for new/up-gradation of fishing vessels/boats, Bio-toilets, Sagar Mitras, Fisheries FPOs/Cs, Fisheries and Aquaculture start-ups, Integrated Aqua parks, Integrated coastal fishing villages development, E-Trading/Marketing etc.

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Agriculture

Chapter 5

Short Answers

CSM-05: Compiled by Prof. Ashok Vishandass

22

This chapter contains:

- Sustainability Approach in Agriculture
- Management of Soil Organic Carbon
- Agro-ecological Based Agriculture
- Conservation Agriculture and Residue Management
- Climate Change
- Agro-biodiversity for Smart Ecological Services
- Watershed Management
- Rainfed Agriculture: challenges and strategies
- Organic Farming
- Integrated Farming System

Contents

1. Sustainability Approach in Agriculture

Agriculture is a primary production system in India that makes a significant contribution to the wealth and quality of life for rural and urban communities. It is apparent that income increases for farm households can be made sustainable, only if agricultural income improvement is driven by approaches and practices, that do not erode the very productive resources on which agriculture is based. Otherwise, the income increases are bound to be short-lived. Green Revolution (GR) has changed the traditional pattern of cropping for higher efficiency & productivity of the production systems. If 1950's was the decade of development and expansion of irrigation and 1960's of intensification of high yielding variety (HYV) in the most favourable environments, 1970's one of exploitative agriculture confined to more favourable ecologies through integration of HYV, fertilizer and pesticide based technology, particularly of wheat and rice. It was only in the late 70's or early 80's that the need for appropriate technology for rainfed, under-invested dry farming and stressed ecologies, was recognized. These were areas that had remained beyond the pale of GR technology.

In the decade of 1990's, the limitations of the exploitative agriculture that was based only on crops, commodities and cropping systems came to be increasingly recognized, and emphasis shifted to alternative and sustainable land use systems, and for improving efficiency of resources and inputs. Degradation of natural resources has direct consequences in terms of productivity but also on the ability of the farm to withstand biotic and abiotic stresses. In the decade of 2000s, and thereafter even with the best possible efforts, the sustainability of productivity is in question in many production systems implying that though the problems was recognised in the earlier decades, total solutions were not found.

It is unfortunate that ever since independence especially after 1960’s, the emphasis in Indian agriculture has been more on exploitation of natural resources of land and water and less on improving, restoring, reclaiming and enhancing their productivity and sustainability. Presently, Indian agriculture is facing the critical challenge of feeding an escalating human population under increasingly declining soil quality and changing climatic conditions. It supports18 per cent of the human and 15 per cent of livestock populations of the world on only 2.2 per cent of the world geographical area, 4.2 per cent of freshwater resources, 1 per cent of forest area and 0.5 per cent of pasture land. Further, the extent of arable land is 46 per cent of the country’s land mass.

Sustainable agriculture is the successful management of resources for agriculture to satisfy the changing human needs, while maintaining or enhancing the quality of environment, improving the social and economic conditions of the farmers, their employees and local communities, and safeguards the health and welfare of farmers and conserving renewable natural resources.

Various agents of degradation of natural resources (land degradation, deterioration of soil health, water scarcity, soil-water -air pollution, deforestation, climate change, loss of biodiversity) and their consequences on food security and sustainability are discussed in details in the subsequent sections that follow.

1.1 Degradation of Natural Resources

Land and its degradation

Land in India suffers from varying degrees and types of degradation stemming mainly from unstable use and inappropriate management practices. Loss of vegetation occurs due to deforestation, cutting beyond the silviculturally permissible limit, unsustainable fuel wood and fodder extraction, shifting cultivation, encroachment into forest lands, forest fires and overgrazing, all of which subject the land to degradation forces.

Other important factors responsible for large-scale degradation are the extension of cultivation to lands of low potential or high natural hazards, non-adoption of adequate soil conservation measures, improper crop rotation, indiscriminate use of agro-chemicals such as fertilizers and pesticides, improper planning and management of irrigation systems, and extraction of ground water in excess of the recharge capacity.

Potential erosion rates

It is estimated that about 5,334 million tonnes of soil is lost annually which works out to 16.35 tonnes/ha (Dhruva Narayana and Ram Babu, 1983) of which 29 per cent is lost permanently into the sea, 10 per cent gets deposited in the reservoirs decreasing their capacity by 1-2 per cent every year and the remaining 61 per cent is displaced from one place to another or redistributed. Among different land resource regions, highest erosion rate occurs in the Black soil region (23.7–112.5 t/ha) followed by Shiwalik region (80 t/ha), North-Eastern region with Shifting Cultivation (27-40 t/ha) and the least in North Himalayan Forest region (2.1 t/ha).

The analysis revealed that about 39 per cent area in the country is having erosion rates of more than permissible rate of 10 t/ha/yr. About 11 per cent area in the country falls in very severe category with erosion rates of more than 40 t/ha/yr. Some of the States in the North-West and North-East Himalayas are worst affected with more than 1/3rd of their geographical area falling in very severe (40-80 t/ha/yr) category. Land erosion effects agricultural productivity.

Consequences of land degradation

The land degradation has both on-site and off-site effects. On-site effects include the lowering of productive capacity of the land, causing either reduced outputs or need for increased inputs. Off-site effects of water erosion that occur through changes in the water regime encompass decline in water quality, sedimentation of river bodies and reservoirs, loss of biodiversity and natural disasters like floods and droughts. The irrigated agriculture especially through canal systems has resulted in land degradation at many places due to the twin problems of waterlogging and salinization. It is estimated that nearly 8.4 million ha of the irrigated lands are affected by soil salinity and alkalinity, of which about 5.5 million ha is waterlogged (IDNP, 2002).

Soil and deterioration of soil health

Soils provide the basis for life, giving nutrients to plants, which allow animal and human life to exist. Being a tropical country, the organic carbon content of the Indian soils is very low and deficiency of

N is almost universal. The status of N is low in about 48 per cent of the area and medium in about 42 per cent. The status of phosphorus and potassium was low in 25 and 27 per cent, and medium for phosphorus and potassium in about 67 and 70 per cent area, respectively.

The high biomass production capacity of Indian soils is being gradually eroded both at farm level and also at ecosystem level. At farm level, factors like (i) inability of growers to use modern techniques on small land holdings; (ii) maintenance of soil organic matter and nutrients balance at farm; and (iii) increased wind and water erosion, are limiting the crop production. At ecosystem level, excessive accumulation of reactive N (Nr), CH4 and CO2 are threatening production capacity by altering global heat balance and hydrological cycles.

Threats at farm level

About 29.4 m ha of the nation's soils are experiencing decline in fertility with a net negative balance of 8-10 m tons of nutrients per annum, which is likely to increase in future. The current estimated average depletion per ha is about 16 kg N, 11 kg P2O5 and 42 kg K2O. Besides, continuous mining of secondary and micro-nutrients has depleted nutrient reserves of soil. With negative nutrient balance, the deficiencies may become more widespread and acute leading to further decline in fertilizer use efficiency. Fertilize N use efficiency seldom exceeds 40 per cent under low land and 60 per cent under upland farming conditions. In case of P and micronutrients, the efficiency hardly exceeds 20 and 2 per cent, respectively even with the best management practices. Thus, rational use of fertilizer and manure for optimum supply of all essential nutrients which simultaneously ensures efficiency of fertilizer use, promotes synergistic interactions and keeps antagonistic interactions out of crop production system would be essential and inevitable for balanced fertilization.

The contributions of soil organic carbon (SOC) on physical, chemical and biological properties of soils in sustaining their productivity are being appreciated since the dawn of human civilization. In most Indian soils, organic matter content is low but it is also dynamic in nature. Farming practices affect both quantity and quality of organic matter. In general, the SOC content in Indian soils is about 0.5 per cent.

Other factors such as declining livestock population and reduced applications of farm yard manure and green manure crops are also reasons of soil fertility loss. Urgent measures are required to arrest the degradation process and to restore productivity of degraded soils so that more food could be produced to provide livelihood and environmental security to the increasing Indian population. Erosion affects nutrient cycling and reduces the fertility of the soil by reducing the pool of available nutrients.

Problems of water logging and salinity in Indian agriculture are typically associated with canal irrigation. Salinity occurs when the water table rises with percolating irrigation water. When water table is a meter or so below the soil, water flows to the surface, evaporates and leaves the salt deposits. When poor quality groundwater is pumped up, salt is left in soil as it evaporates. About 4.1 m ha of India's land is affected by salinity (Lal, 2004). It is particularly a serious problem in Uttar Pradesh and Gujarat.

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2. Management of Soil Organic Carbon

Despite impressive gains in cereal production from 50 million tonnes in 1947 to about 253 million tonnes in 2017, there remain two serious but inter-related problems. One, expected food demand of 300 million tonnes of cereals by 2030 which must be met from the shrinking land resource base. Two, there are severe problems of degradation of soil and water resources leading to reduction in use efficiency of inputs, pollution of surface and ground waters and emission of greenhouse gases (GHGs) from soil into the atmosphere. Most intensive cereal based production systems are showing declining trend in grain output. A decrease in soil C is one of the causes of yield decline in India (Ladha et al. 2003). In long-term experiments of India, decline in soil organic matter is the major cause of yield decline (Swarup et al. 2000) irrespective of cropping system and soil type. This eventually leads to deterioration of soil quality. The problem is further enhanced by reduced biomass productivity and the low amount of crop residue and roots returned to the soil. Low soil organic carbon content is also attributed to heavy ploughing, removal of crop residue & other bio-solids and indiscreet mining of soil fertility.

The amount of organic carbon in soils of India is relatively low ranging from 0.1 to 1 per cent and typically less than 0.5 per cent. Understanding long term soil organic carbon changes in various ecosystems is of prime importance, because it directly affects soil quality and serves as a major pool of plant nutrients. The biomass produced above ground in agricultural or natural ecosystems is either removed from the system or remains on the soil surface. These changes in SOC, in turn, lead to increasing dependence on in-organic fertilisers, risk of erosion, lower crop yields and ultimately global warming.

2.1 Carbon Stock in different Agro-climatic Regions of India

Each soil has a carbon carrying capacity i.e., an equilibrium carbon content depending upon the nature of vegetation, precipitation and temperature. When the equilibrium is disturbed, as for example by forest clearing, intensive cultivation etc., soil carbon rapidly declines. In the cool and humid climates, soils can have 6-7 per cent SOC content in their surface layers. In contrast, cultivated soils of the arid and semiarid tropics contain a low level of SOC at 0.2-0.3 per cent of those in India. In tropical and sub-tropical areas, decomposition and the turnover of SOC tend to be faster.

The climate in combination with type of soil also influences the SOC content. It has been reported, that SOC in soils ranged from less than 1 per cent in sandy soils to almost 100 per cent in wetland soils. Of course, carbon stores in arid and semi-arid lands show high temporal and spatial variability, some parts acting as carbon sources and others as carbon sinks. In arid and semi-arid zone tropical soils of India, nearly 50 per cent of the carbon is lost. Jenny and Rayachaudhury's classical study on Indian soils showed depletion to be as high as 60-70 per cent in many soils.

2.2 Carbon Losses

The soil organic carbon pool in 1m depth ranges from 30 t/ha in arid climates to 800t/ha in organic soil of cold regions, with a predominant range of 50-150 t/ha. The soil organic carbon pool represents a dynamic equilibrium of gains and losses. Losses and gains of SOM are influenced by land management practices such as cropping frequency, reduced tillage, and fertiliser/manure application and also by cultivation of perennial legumes and grasses. The depletion is exacerbated when the output of carbon exceeds the input and when soil degradation is severe.

A decline in SOC content is a common phenomenon when land use changes from natural vegetation to cropping, reasons being reduction in total organic carbon inputs, increased rate of decomposition due to mechanical disturbance of the soil, higher soil temperatures due to exposure of the soil surface, more frequent wetting and drying cycles and increased loss of surface soil rich in organic matter through erosion.

Low external input of chemical fertilizers and organic amendment causes depletion of SOC pool, because nutrients harvested in agricultural products are not replaced, and are made available through mineralization of soil organic matter (SOM).

Maintenance of soil structure in any soil type strongly influences soil C residence times, and thus management and disturbance can lead to substantial losses of soil C. Frequent disturbance to the soil (i.e., tillage) exposes protected organic matter and increases the rate of decomposition, decreased aggregate stability resulting in lower steady-state SOC storage. Excessive tillage and intensive cultivation in semi-arid region reduced soil organic carbon density from 60 kg km^{-2} under single cropping to 10.5 kg km^{-2} under double cropping.

Decrease in soil organic carbon pool may be caused by three, often simultaneous processes viz., mineralization, erosion, and leaching.

Mineralization: Most of the biomass produced in the natural ecosystem is returned into the soil. However, the rate of mineralization in agriculture ecosystem often exceeds the rate of carbon accretion occurring through addition of roots and biomass. Higher soil temperature increases the rate of mineralization of SOC pool (Jenny and Raychaudhury, 1960). Due to high temperature, soils of tropical, subtropical, arid and semi-arid regions are expected to be contributing more oxidative products. Long-term cultivation reduced SOC storage, but losses varied depending on the climate in the order: tropical moist>tropical dry>temperate moist>temperate dry.

Soil erosion: Conversion of natural ecosystem to agricultural use generally leads to significant increase in the rates of soil erosion by both water and wind. In general, the ratio of C content of water and wind-borne sediments to that of contributing soil (C enrichment ratio) is always greater than one. Thus, the detachment of aggregates and redistribution of carbon rich sediments over the landscape may accentuate loss of carbon from soil to the atmosphere.

Leaching: The soluble fraction of SOC pool, called dissolved organic carbon (DOC), can be leached out of the soil profile with seepage water (Moore, 1998). While a component fraction of the DOC transported into the ground water may be precipitated and sequestered, a large portion may be mineralized and released into atmosphere as CO2. Some soils have lost as much as 20-80 t C/ha mostly emitted into atmosphere. Crop cultivation is known to adversely affect distribution and stability of aggregates and reduces organic carbon stock in soil. In other words, the low SOC pool in soils of India is partly due to the severe problem of soil degradation.

2.3 Management of Soil Organic Carbon (SOC)

The amount of SOC depends on soil texture, climate, vegetation and historical and current land use/ management practices. Mean annual rainfall, tillage, period of canopy cover, available water capacity (AWC), silt and clays also have pronounced effects on carbon dynamics. The SOC is sensitive to impact of human activities, viz. deforestation, biomass burning, land use changes, soil disturbances and environmental pollution.

I. Carbon sequestration
II. Options for sequestering carbon in soils
III. Conservation tillage and cycling
IV. Nutrient management and cropping systems
V. Cover crops and fallowing
VI. Plant roots and carbon sequestration
VII. Agro-forestry and agro-pastoral systems
VIII. Residue management and mulching
IX. Water management
X. Cropping systems and crop diversification

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3. Agro-ecological Based Agriculture

The realization of the contribution of peasant agriculture to food security amidst the challenging context of climate change, economic and energy crisis, led to the concepts of food sovereignty and agro-ecologically based production systems gaining much attention in the developing world in the last two decades. New approaches and technologies involving application of blended modern agricultural science and indigenous knowledge systems and spearheaded by thousands of farmers, NGOs, and some government and academic institutions are proving useful in enhancing food security while conserving agro-biodiversity soil and water resources across the developing world.

The agro-ecology based development involves revitalization of small farms which emphasizes diversity, synergy, recycling and integration; as also social processes that value community participation and empowerment. It is an option that balances economic needs and ecological challenges related to agriculture. Given the present and predicted near future climate, energy and economic scenarios, agro-ecology has emerged as one of the most robust pathways towards designing bio-diverse, productive, and resilient agro-ecosystems.

Most traditional agro-ecosystems exhibit five similar and remarkable features:

- High levels of biodiversity that play a key role in regulating ecosystem functioning and also in providing ecosystem services of local and global significance

- Ingenious systems and technologies of landscape, land, and water resource management and conservation that can be used to improve management of agroecosystems

- Diversified agricultural systems that contribute to local and national food and livelihood security;

- Agro-ecosystems that exhibit resilience and robustness to cope with disturbance and change (human and environmental) minimizing risk in the midst of variability

- Agroecosystems nurtured by traditional knowledge systems and farmers innovations and technologies

- Socio-cultural dimension, regulated by strong cultural values and collective forms of social organization including customary institutions for agro-ecological management, normative arrangements for resource access and benefit sharing, value systems, rituals, etc.

Proponents of the Green Revolution technology and other modernization schemes assume that transformation progress and of traditional agro-ecosystems requires the replacement of local crop varieties by improved ones; and that the economic and technological integration of traditional farming systems into the global system enables increased production, income, and well-being. The conventional wisdom is, that small family farms are backward and unproductive, and that peasant agriculture generally lacks the potential of producing meaningful marketable surplus, and ensuring food security. Many scientists believe that traditional systems do not produce more because hand tools and draft animals put a ceiling on productivity. This may not be totally correct. Productivity may be low but the causes appear to be more social, not technical.

3.1 Irrigated Eco-system

Irrigated system in India occupies a unique place in its agriculture helping achieve impressive output of several agri-commodities. Around 48 per cent of the cultivated area is under assured irrigation. With advancement in irrigation facilities in northern India, wheat (Triticumaestivum L.), rice (Oryzasativa L.), and maize (Zea mays L.) crops are predominating. In other parts of the country too, dependable irrigation has come to support intensive production system. However, irrigated productions systems in the country are mainly cereal dominated. Recent evidences show that continuous cereal–cereal production systems have come under stress. Irrigated systems of irrigation has resulted in overuse, and large extents have come to suffer from soil health deterioration. The extent of problematic soils – acidic and alkaline is as high as 24 million ha in the country. The fast declining ground water table and factor productivity in rice–wheat cropping system of Indo-Gangetic Plains (IGP) indicate the situation of over-exploitation of natural resources.

3.1.1 Challenges in irrigated areas

In the post-green revolution era, resource conservation issues have begun to demand attention in view of the widespread land and water degradation problems linked to mechanized intensive tillage in rice-wheat cropping system. There is a need for shifting cropping systems and/or production practices in accordance to the resource availability, particularly in respect of soil characterization and water availability. More than 80 per cent of the water available in the country is already being used in agriculture, of which two-thirds is allocated to rice cultivation. Ironically, rice requires about 4,000–5,000 litres of water for production of 1 kg grain with conventional puddled planting method. This is unaffordable, given the situation of water deficiency in India.

Climate change is another challenge likely to have impact on agricultural land use and production. This may be due to less availability of irrigation water, higher frequency and intensity of inter and intra-seasonal droughts and floods, low soil organic matter, soil erosion and constraints of energy. Therefore, rice crop cultivation should be discouraged in IGPs with light texture soils, like loamy sand and sandy loam. These soils have low water retention capacity. Diversification by replacing the rice crop or by inclusion of suitable crops in the cropping systems is a matter of urgency. The diversified cropping systems including pigeon pea-wheat, maize-wheat, and inclusion of pulses in the rice-based cropping systems is the need of the hour.

3.1.2 Improved agro-techniques for irrigated systems

- **I.** Laser land levelling
- **II.** Conservation tillage (zero/minimal tillage)
- **III.** Bed planting (narrow/broad beds)
- **IV.** Direct-seeded rice
- **V.** Furrow irrigated raised bed system of planting

3.2 Rainfed agro-ecology

With limited access to dependable sources of irrigation, rainfed agriculture is as high as 54 per cent of the net cultivated area. Rainfed agriculture is as old as agriculture itself. Growing of crops entirely under rainfed conditions particularly where quantum of precipitation is low, is known as dryland agriculture. Depending on the amount of rainfall received, dryland agriculture can be grouped into three categories:

a) Dry farming: is cultivation of crops in regions with annual rainfall less than 750 mm. Crop failures are most common due to prolonged dry spells during the crop period. These are arid regions with a growing season (period of adequate soil moisture) less than 75 days. Moisture conservation practices are necessary for crop production.

b) Dry land farming: is cultivation of crops in regions with annual rainfall more than 750 mm. In spite of prolonged dry spells, crop failure is relatively less frequent. These are semi arid tracts with a growing period between 75 and 120 days. Moisture conservation practices are necessary for crop production. However, adequate drainage is required especially for vertisols or black soils.

c) Rainfed farming: is crop production in regions with annual rainfall of more than 1150 mm. Crops are not subjected to soil moisture stress during the crop period. Emphasis is often on disposal of excess water. These are humid regions with growing period of more than 120 days.

3.3 Constraints in Dryland farming

Inadequate and uneven distribution of rainfall

In general, the rainfall is low and highly variable which results in uncertain crop yields. Besides its uncertainty, the distribution of rainfall during the crop period is uneven, receiving high amount of rain when it is not needed, and lack of it when crop needs it.

Late onset and early cessation of rains

Due to late onset of monsoon, the sowing of crop is delayed resulting in poor yields. Sometimes the rain may cease very early in the season exposing the crop to drought during flowering and maturity stages which reduces the crop yields considerably.

Prolonged dry spells during the crop period

Long breaks in the rainy season are an important feature of Indian monsoon. These intervening dry spells when prolonged during crop period reduces crop growth and yield and when unduly prolonged crops fail.

Low moisture retention capacity

The crops raised on red soils, and coarse textured soil suffer due to lack of moisture whenever prolonged dry spells occur due to their low moisture holding capacity. Loss of rain occurs as runoff due to undulating and sloppy soils.

Low fertility of soils

Drylands are not only thirsty, but also hungry too. Soil fertility has to be increased, but there is limited scope for extensive use of chemical fertilizers due to lack of adequate soil moisture. Hence, more of organic based manuring is the option.

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4. Conservation Agriculture and Residue Management

Today, Conservation Agriculture (CA) is practised globally on an estimated 155 million hectares in all continents and agricultural ecologies. USA, Brazil, Argentina, Canada and Australia account for about 90 per cent of the area under conservation agriculture in the world (100mha). The conservation agriculture, which is advocated as an alternative to the conventional production system, has been adopted by the Food and Agriculture Organization (FAO) of the United Nations as a lead model for improving productivity and sustainability. Recent estimates have revealed, that conservation agriculture-based resource conserving technologies (RCTs) that include laser assisted precision land levelling, zero/reduced tillage, direct drilling of seeds, direct seeding of rice, unpuddled mechanical transplantation of rice, raised bed planting and crop diversification are being practised over 3 mha in South Asia.

In India, there are divergent views on the extent of area under CA. Derpschet al., 2010 estimated that CA is practised on about 1.5 m ha in IGP, and is otherwise known through resource conservation technologies (RCTs). The spread of CA is largely concentrated in the rice–wheat system in the IGP of the country. Indian IGP comprises of Trans (GP), Upper (GP), Middle (GP) and the Lower (GP). The IGP of South Asia includes India, Nepal, Bangladesh and Pakistan.

4.1 Genesis of Conservation Agriculture

Concerns about stagnating productivity, burning of crop residues, increasing costs of management of crop residues, declining resource quality, declining water tables and increasing environmental problems are the major factors forcing a look at alternative technologies, particularly in the northwest region encompassing Punjab, Haryana, western Uttar Pradesh (UP) and Uttarakhand. In the eastern region covering eastern UP, Bihar and West Bengal, developing and promoting strategies to overcome constraints for continued low cropping system productivity have been the chief concern.

4.2 Managing Crop Residues through Conservation Agriculture

The primary focus of developing and promoting CA practices in India has been the development and adoption of zero tillage cum fertilizer drill for sowing wheat crop in rice– wheat system. Other interventions being tested and promoted in the IGP include raised-bed planting system, laser-aided land-levelling equipment, residue management alternatives, and alternatives to rice–wheat cropping system in relation to CA technologies. The area planted with wheat by adopting zero-tillage drill has been rapidly increasing in last few years. It is estimated that over the past few years, adoption of zero-tillage has expanded to cover about 2 m ha. The rapid adoption and spread of zero tillage is attributed to benefits resulting from reduction in cost of production, reduced incidence of weeds and therefore savings on account of herbicide costs, savings in water and nutrients and environmental benefits. Adopting CA systems further offers opportunities for achieving greater crop diversification. Crop sequences/rotations and agroforestry systems, when adopted in appropriate spatial and temporal patterns, can further enhance natural ecological processes which contribute to system resilience and reduced vulnerability to yield, thus reducing disease and pest problems.

Zerotillage when combined with appropriate surface-managed crop residues sets in processes, whereby, slow decomposition of residues results in structural improvement of soil and increased recycling and availability of plant nutrients. Surface residues are also expected to improve soil moisture regime, improve biological activity and provide a more favourable environment for growth. These processes, however, are slow and results are expected only with time.

4.3 Weed Management for Conservation Agriculture system

Increasing concern about weed interference in CA systems has necessitated the inclusion of weed management as one of the basic principles of CA. Globally, weeds proliferation within CA based systems is a challenging management problem (Lafondet al., 2009; Nathet al., 2017), particularly with the increase development of herbicides resistance weeds. Importantly, soil cover with residue retention and crop rotation, which are fundamental principles of CA are in themselves methods of weed control, yet CA systems rely on herbicides for weed management. Minimum soil disturbance over a long term practice also reduces the weed populations from the absence of practices that creates favourable germinating conditions and encourages dormant weed seeds at the surface through tillage. Crop rotation is an effective practice for weed control. Rotating crops with different life cycles is very effective in controlling problematic weed like Phalaris minor inwheat. The retention of crop residue in suppressing weeds is well documented. Thus, CA can go a long way in reducing weeds and its seedbanks over time.

4.4 Utilization of Crop Residues in Conservation Agriculture

India produces more than 500 million tons of crop residues annually. Besides using as animal feed, for thatching of homes, and as a source of domestic and industrial fuel, a large portion of unused crop residues is burnt in the fields primarily to clear the left-over straw and stubbles after the harvest. Non-availability of labour, high cost of residue removal from the field and increasing use of combines in harvesting the crops are main reasons behind burning of crop residues in the fields. A package of intervention is needed to resolve the economic and ecological issues.

4.5 Impact of Conservation Agriculture

To be widely adopted, all new technologies have to prove their benefits and advantages, to a broad group of farmers to understand the differences between what is being practised and what needs to change. In the case of CA these benefits can be grouped as:

- Economic benefits that improve production efficiency.
- Agronomic benefits that improve soil productivity.
- Environmental and social benefits that protect the soil and make agriculture more sustainable.

4.6 Using Crop Residues in Conservation Agriculture – Constraints

A series of challenges exist in using crop residues in conservation agriculture. These include difficulties in sowing and application of fertilizer and pesticides, and problems of pest infestation.

The conservation agriculture with higher levels of crop residues usually requires more attention on timings and placement of nutrients, pesticides and irrigation. Lot of improvement has been done in the zero-till seed-cum fertilizer drill system to give farmers a hassle-free technology. Weed control is the other bottle-neck, especially in the rice-wheat system. Excessive use of chemical herbicides may not be desirable for a healthy environment. Nutrient management may become complex because of higher levels of residues and reduced options for application of nutrients, particularly through manure.

Application of fertilizers, especially N entirely as basal dose at the time of seeding may result in a loss in its efficiency and environmental pollution. Sometimes, increased application of specific nutrients may be necessary and specialized equipments are required for proper fertilizer placement, which will add to the costs. No-till in particular can complicate manure application and may also contribute to nutrient stratification within soil profile from repeated surface applications without any mechanical incorporation. Similarly, increased use of herbicides may become necessary for adopting conservation agriculture. Countries that use relatively higher amounts of herbicides are already facing such problems of pollution and environmental hazards. Further limiting factor in adoption of residues incorporation systems in conservation agriculture by farmers include additional management skills, apprehension of lower crop yields and/or economic returns, negative attitudes or perceptions, and institutional constraints. In addition, farmers have strong preferences for clean and good looking tilled fields vis-a-vis untilled shabby looking fields.

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5. Climate Change

Climate change is the dominant environmental challenge of the current time facing decision makers and planners. Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures. Eleven years from 1995-2006 rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850). The 100-year linear trend (1906-2005) of 0.74 [0.56 to 0.92] °C is larger than the corresponding trend of 0.6 [0.4 to 0.8]°C (1901-2000) and over the 21st century average temperature of earth surface is likely to go up by an additional of 1.8- 4 oC (IPCC, 2007). This temperature increase can be attributed to the altered energy balance of the climate system resulting from changes in atmospheric concentrations of the greenhouse gases (GHGs).

Among the principal components of radiative forcing of climate change, CO2 has the highest positive forcing leading to warming of climate. CO2 has the least global warming potential among the major greenhouse gases but due to its much higher concentration in the atmosphere, it is the major contributor towards global warming and climate change. Agriculture sector in India contributes 28 per cent of the total GHG emissions (NATCOM, 2004). The global average from agriculture is only 13.5 per cent (IPCC, 2007). In future, the percentage emissions from agriculture in India are likely to be smaller due to relatively much higher growth in emissions in energy-use transport and industrial sectors.

5.1 Climate Change Scenarios for India

The warming trend in India over the past 100 years has indicated an increase of 0.60°C. The projected impacts are likely to further aggravate field fluctuations of many crops, thus impacting food security. There are already evidences of negative impacts on yield of wheat and paddy in parts of India due to increased temperature, water stress and reduction in number of rainy days. Significant negative impacts have been projected with medium-term (2010-2039) climate change, for example, yield reduction by 4.5 to 9 per cent, depending on the magnitude and distribution of warming. Since, agriculture makes up roughly 15 per cent of India's GDP/ GVA, a 4.5 to 9.0 per cent negative impact on production implies the cost of climate change to be roughly at 1.5 per cent of GDP/GVA per year.

India has a highly seasonal rainfall pattern with about 75 per cent of the long term average annual rainfall occurring during the southwest monsoon (rainy) season. This period is spread over the months of June to September. The year to year variability in monsoon rainfall leads to extreme hydrological events, such as drought and floods in different parts of the country, affecting agricultural production. Analysis of the historical trends in yields of rice and wheat crops in the IGP has shown decline in grain yields of rice and wheat and this could partly be related to the gradual change in weather conditions (Aggarwal et al. 2004).The anticipated climate change and variability with changes in air temperature and precipitation pattern will have reflective effect on regional water availability, and would further exacerbate the current situation of water scarcity.

5.2 Causes of Climate Change

There is nothing new about climate change. For hundreds of millions of years the Earth's temperature has been influenced by continental shifts, which have triggered volcanic eruptions among other things. Sometimes these shifts released large volumes of CO2 which heated up the Earth. Today, it is understood that natural phenomena, even though occurring in faraway geographies, make a deep impression on the climate across the globe.

5.3 Impact of Climate Change on Agriculture

Agriculture and fisheries are highly dependent on the climate. Interestingly, increases in temperature and CO2 can increase some crop yields in some places. But to realize these benefits, nutrient levels, soil moisture, water availability, and other conditions must also be met. However, rise in temperature has a deleterious impact on water and seasonal crops like wheat which is an important cereal in the Indian food basket. Changes in the frequency and severity of droughts and floods could pose challenges for farmers threaten food safety. Meanwhile, warmer water temperatures are likely to cause the habitat change of many fish and shellfish species to shift and also damage ecosystem. Overall, climate change could make it more difficult to grow crops, raise animals, and catch fish in the same ways and same places as done in the past. The effects of climate change also need to be considered along with other evolving factors that affect agricultural production, such as changes in farming practices and technology.

5.4 Issues around Climate Change

Disturbed C-cycle

Plant produces carbohydrate by using the natural resources and maintains the ecosystem. When civilization was at initial stage or later when human population was small, there was integrity between human society and environment. The modern agriculture with the robust pace of output has disturbed the ecosystems.

Removal of carbon from the fields

By harvesting the crop, one is removing the biomass from field and it is responsible for carbon removal from soil. Residue burning (Figure 5.3) is a major violater of ecology as discussed in earlier secton. It also emits large amount of particulates that are composed of wide variety of organic and inorganic species. Burning of crop residue increase the nutrient loss. Pedology is the basis for agricultural and rural sustainability. The heat from burning cereal straw can penetrate into soil upto 1 (one) cm elevating the temperature to as high as 33.8-42.2O c. About 32-76 per cent of the straw weight and 27-73 per cent N are lost in burning. Bacterial and fungal populations decrease immediately and substantially only on top 2.5 cm upon burning. Repeated burning in the field permanently diminishes the bacterial population by more than 50 per cent. Burning immediately increased the exchangeable NH4-N and bicarbonate extractable Phosphorus content but there is no build up of nutrients in the profile. Long term burning reduces total N and C and potentially mineralized N in the 0-15 cm soil layer. One of the recognized threats to rice-wheat system sustainability is the loss of soil organic matter as a result of burning.

Methane recovery

• Animal waste methane recovery & utilization.

• Installing an anaerobic digester & utilizing methane to produce energy

• Coal mine methane recovery.

• Collection & utilization of fugitive methane from coal mining.

• Capture of biogas.

• Landfill methane recovery and utilization.

• Capture & utilization of fugitive gas from gas pipelines.

• Methane collection and utilization from sewage/industrial waste treatment facilities.

Agricultural sector

• Energy efficiency improvements or switching to less carbon intensive energy sources for water pumps (irrigation).

• Methane reductions in rice cultivation.

• Reducing animal waste or using produced animal waste for energy generation.

• Any other changes in an agricultural practices resulting in reduction of any category of greenhouse gas emissions.

5.5 Mitigation Strategies

These are the actions to reduce greenhouse gas emission and sequestration or storage of carbon in the short-term and developmental choices that will be lead to low emission in the long-term.

a) Reducing emissions of carbon dioxide, methane and nitrous oxide: reduction in the emission of greenhouse gases by changing the practice of transplanting rice with the direct seeded rice/ aerobic rice which require less water and due to aerobic conditions the emission of CH_4 and CO_2 gases will be less.
b) Sequestering carbon: sequestering atmospheric carbon is very important as without reducing the atmospheric level of carbon, it is not possible to mitigate the climate change. The switch over to carbon sequestering practices is recommended.
c) Resource conservation technologies: any method, material or tool which enhances the input use efficiency, crop productivity and farm gate income is termed as resource conservation technology. It includes:
   • crop establishment system (zero tillage, minimum tillage or reduced tillage etc.);
   • water management (adoption of laser land leveller technique); and
   • nutrient management (use of SPAD or SSNM or slow release fertilizers etc.)

d) Enriching soil organic matter: by applying FYM, compost or by practising organic farming we can improve the soil organic matter which can help in improvement of soil health.

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6. Agro-biodiversity for Smart Ecological Services

Since the dawn of civilization, natural resources of land, soil, water, bio-diversity and climate form the very basis for supporting and sustaining life of human beings, plants and animals on the earth. However, in recent times, intensive use and over-exploitation of these pristine resources have robbed them of their legendry resilience. To effectively tackle the complex problems of livelihood and food security, poverty, unemployment, equity and environmental services, efficient and judicious utilization of natural resources and ecological intensification for enhanced and sustained productivity, is a matter of serious concern for policy makers, planners, scientists, conservationists and environmentalists. The strategy need for building the national food security and the circumstances that obtained in the 1960's led to adoption of technology that warranted intensive use of natural resources of land and water. The emphasis was not so much on improving, restoring, reclaiming and enhancing their productivity and sustainability of land race, and also safeguarding the bio-diversity.

Agro-biodiversity is the variety and variability of bio-resources in a region at a point of time. The diversity includes plants, animals, soil micro-organisms and of course the human being. This is directly or indirectly related to food and agriculture- crop and animal husbandry, forestry and fisheries. The genetic resources i.e., varieties, breeds and species have existed and are used for food, fodder, fiber, fuel and also pharmaceutical production. The degree or the extent of agro-biodiversity may change over time due to natural and continuous man-made activities. There may be resurgence of new bio-resources due to natural or artificial genetic modification. The inherent productivity of agro-ecosystem largely depends on the agrobiodiversity of a region. The interaction, very complex and varied, is the most important phenomenon among different components of bio-resources and also with climate in sustenance and functioning of the agro-biodiversity of a region. Local knowledge and culture among people can be considered as a part of agro-biodiversity, because it is the human activity towards agriculture that shapes and conserves this bio-diversity.

6.1 Major Concerns

The loss of bio-diversity is likely to be further aggravated by the increasingly rapid, large scale global extinction of species. It occurred in the 20th century at a rate that was thousands of times higher than the average rate during the preceding 65 million years. This is likely to destabilize various ecosystems including agricultural systems. India is endowed with diverse ecosystems such as tropical rain forests, temperate forests, alpine vegetation, wetlands and mangroves. However, over-exploitation, habitat destruction, pollution and species extinction are major causes of bio-diversity loss in India. Other factors include fires, which adversely affect regeneration in some cases.

According to the National Forest Policy, at least 60 per cent of the reporting area in the hills should be under forests. The States of Arunachal Pradesh, Himachal Pradesh., Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and Uttarakhand fulfill this criterion, whereas in other hilly states, such as Assam and Jammu and Kashmir (J&K), the area under forests is much lesser than the recommended one. Overall, 124 districts of the country have forest cover of 38.85 per cent of their total geographical area (FSI, 2005).

For maintaining the long-term services of the hill and mountain ecosystems as a valuable storehouse of water resources in the country, protection and management of upper catchments is of paramount importance. Bio-diversity of various ecosystems needs to be preserved to generate multiple and wide-ranging on-site and off-site economic benefits.

6.2 Status of Agro-biodiversity

Plant genetic resources

Presently as many as 3,58,571 accessions of 1,134 species in seed gene bank; 1,973 accessions of 158 vegetatively propagated crops under in vitro; and 8,493 accessions of 720 species have been cryo preserved (www.nbpgr.ernet.in). New protocols have been developed for micropropagation and in-vitro conservation of vegetative propagated species and also for cryopreservation of vegetative propagated and non-orthodox seed species like tea, black pepper, almond, neem, etc.

The initiatives for on-farm conservation of landraces and crops of local importance have been recently undertaken in Western Himalayan region and Bastar area of Chattisgarh. Several civil society organizations have also taken initiative to conserve many precious landraces and crop species. The Union Ministry of Environment and Forests has facilitated conservation of natural flora, through its field organizations. The entire spectrum of this component of plant biodiversity is distributed over 10 bio-geographical zones and is being conserved in situ in 92 National Parks, 504 Sanctuaries and 15 Biosphere Reserves spread over 16.00 million ha (MoEF 2008). There are about 1,00,000 to 1,50,000 sacred groves and micro-eco-systems, and 309 forest preservation plots that provide home to a large number of agriculturally important plants that disappeared from of the surrounding landscapes. About 245 botanical gardens, arboreta, herbal gardens and other field repositories also conserve number of species, particularly of threatened and rare nature. The establishment of sanctuaries in Tura range in Garo Hills of Meghalaya for conservation of rich native diversity of wild Citrus and Musa species, and for Rhododendron and orchids in Sikkim is also helping in-situ conservation of economically important species.

Animal genetic resources

A total of about 48,000 cryo-preserved semen doses representing economically important and fast genetically eroded breeds are being maintained in the Animal Gene Bank. Somatic Cell Nuclear Transfer (SCNT) technique has been standardized.

Fish genetic resources

A database on Fish Diversity of India covering 2,225 indigenous fish species including 79 threatened fish species has been developed (Lakra et al., 2007).

Microbial genetic resources

India shares a significant diversity in microbial diversity. Indian collection has more than 1.18 lakh cultures and accounts for about 14 per cent of the world collection.

6.3 Bio-diversity Management

Bio-diversity management is done at ecosystem, species and gene levels. In situ approach is appropriate at ecosystem, while ex situ approach is adopted for study, conservation and exploitation purposes.

Agro-biodiversity builds the foundation of sustainable agricultural development and is an essential natural resource to ensure current and future food and nutrition security. The effective and efficient management of agro-biodiversity is essential through management of gene banks, science-led innovations; livelihood, food and nutrition security though crop diversification, use of lesser known crops and wild relatives in crop improvement; dealing appropriately the quarantine, bio-safety and bio-security. Wisdom of farmers should be maintained as they have bred thousands of varieties of thousands of species over thousands of years. Paradoxically, the more the seeds are used, the more they are shared and multiplied better are they conserved. To make the best use of agro-biodiversity, and for it to fulfill the needs of the nations food and nutritional security on as sustainable basis, a combination of on-farm, in-situ and ex situ conservation approaches are required.

The importance of agricultural bio-diversity in food security and agriculture has been widely recognized with respect to its functions in climate change adaptation within the agriculture sector. In-situ conservation of agricultural bio-diversity must be made an integral part of agricultural development and be supplemented by ex-situ conservation. Gene sources from traditional varieties and breeds are to be tapped using techniques like allele mining and development of genomic resources for specific traits of interest for high temperature, photoinsensitivity, low respiration and higher photosynthetic rate, drought, flood, salinity, pests etc.

The conservation and use of genetic resources will remain essential for improving productivity in agriculture, and sustaining human existence and wellbeing. Given that global food security depends significantly on production in more industrial agriculture, it is relevant to note the important contribution of agricultural biodiversity to global food production as well as to sustainable livelihoods is in traditional agricultural systems. It is, therefore, inappropriate to promote large-scale abandonment of bio-diverse agriculture and to marginalize it in intensive industrial production systems. The demand for uniformity in the modern world is in a way legislative to low-cost natural management that the nature contains in its order and warrants its maintenance. The challenge is to create a new enabling environment that helps sustainable maintenance of genetic resources and reflects their true value to the livelihoods of different stakeholders. Building complementarities among agriculture, bio-diversity and conservation of genetic resources will also require changes in agricultural research and development, land use, and breeding approaches. The natural populations of many species of crop wild relatives, wild economic species and wild fauna are threatened by habitat loss and by increasing destruction of natural environment.

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7. Watershed Management

A watershed is a defined geographic area through which water flows across the land and drains into a common body of water, whether a stream, river, lake, or ocean. The watershed boundary more or less follows the highest ridgeline around the stream channels and meets at the bottom or lowest point of the land, where water flows out of the watershed, the mouth of the waterway. Much of the water comes from rainfall and storm water runoff. The quality and quantity of storm water is affected by all the alterations to the land--mining, agriculture, roadways, urban development, and the activities of people within a watershed. Watersheds are usually separated from other watersheds by naturally elevated areas.

Importance of Watershed

Watersheds are important, because the surface water features and storm water runoff within a watershed ultimately drain to other bodies of water. It is essential to consider these downstream impacts when developing and implementing water quality protection and restoration actions. Everything upstream ends up downstream.

Declining soil productivity is a great threat to sustainability in agricultural production. It, thus, calls for optimal utilization of soil resources that can only be affected once land use is made as per capability. Incompatible land use is responsible for inducing degradation processes.

Watershed management is a major land development program in the country. It is essential to introduce Referencing System of Watershed at National level as different watershed development programs are operationalized by various departments and ministries. This system will help recognize the watershed by way of national code and avoid duplication on the part of implementing agencies.

Factors affecting Watershed Management

Vegetative cover

It is an important landscape element in any watershed. The distribution of vegetation species may be diverse and highly variable across the watershed, but vegetation communities can be described in more general terms as well. Drainage density can affect the shape of a river's hydrograph during a rain storm. Rivers that have a high drainage density will often have a more 'flashy' hydrograph with a steep falling limb. High densities can also indicate a greater flood risk.

Climatic characteristics

The greatest factor controlling stream flow, by far, is the amount of precipitation that falls in the watershed as rain or snow. However, not all precipitation that falls in a watershed flows out, and a stream will often continue to flow where there is no direct runoff from recent precipitation. The amount of rainfall affects the flow of the streams within the watershed area, and ultimately the quantity of water that is stored in the watershed.

Watershed characteristics

The shape of the watershed contributes to the speed with which the runoff reaches a river. A long and narrow catchment will take longer to drain than a circular catchment. Basin shape is not generally used directly in hydrologic design methods. Watersheds have an infinite variety of shapes, and the shape supposedly reflects the way that run-off will “bunch up” at the outlet. A circular watershed would result in run-off from various parts of the watershed reaching the outlet at the same time. An elliptical watershed having the outlet at one end of the major axis and having the same area as the circular watershed would cause the run-off to be spread out over time, thus producing a smaller flood peak than that of the circular watershed. The size helps determine the amount of water reaching the river, as larger the catchment the greater the potential for flooding. Topography determines the speed with which the run-off will reach a river. Clearly, rain that falls in steep mountainous areas will reach the primary river in the watershed faster than in case of flat or lightly sloping areas. Topographic maps show lines of equal elevation. Watershed slope affects the momentum of run-off. Both watershed and channel slope may be of interest. Watershed slope reflects the rate of change of elevation with respect to distance along the principal flow path. It is usually calculated as the elevation difference between the end-points of the main flow path divided by the length. The elevation difference may not necessarily be the maximum elevation difference within the watershed since the point.

Contributors to water pollution

Common contributors to water pollution are nutrients and sediment which typically enter the stream systems after rainfall washes them off the poorly managed agricultural fields, called surface run-off, or flushes them out of the soil through leaching. These types of pollutants are considered non-point source pollution, because the exact point where the pollutant originated cannot be identified. Such pollutants remain a major issue for water ways, because the difficulty to control their sources hinders any attempt to limit the pollution. Point source pollution originates a specific point of contamination, such as failure of a manure containment structure and its contents entering the drainage system or when a factory discharges its waste directly into a body of water using a pipe.

Management of Watershed

Crops and system management

Crop rotations are required for optimal utilization of land to feed ever increasing population and are useful in reducing pest and disease problems, reducing weed pressure, reducing soil erosion, building organic matter, and supporting a diverse soil microbial community. Rotations that include several crops of different plant families support better soil health than simpler rotations. A diverse crop rotation that includes legumes and deep rooted crops can enhance an efficient cycling and utilization of crop nutrients. On sloping land, integrating a conservation crop rotation with other practices such as strip cropping or contour buffer strips can greatly reduce soil erosion and protect soil health. This includes cover crops, green manures, catch crops in single season crop and alley cropping, inter-cropping, hedgerows, etc., for perennials

Agro-forestry

The single crop areas having saline water (ground water quality) in the block are the best sites for the adoption of the Agro-forestry (with salt tolerant spp.). The concept of Agro-forestry implies the integration of annual crops with perennial trees on the farm to the benefit of the agriculture system. This concept originated from realisation of the fact, that the trees play a vital role in safeguarding the long term interest of the agriculture, and in making farm economy viable. Trees can be incorporated within a farming system by planting them on land which is not suitable for crop production. Trees help to preserve the fertility of the soil through the return of organic matter and fixation of nitrogen. As a result, less run-off is generated and erosion is better controlled. Agro-forestry system requires careful selection of both crop and tree species if a beneficial interaction is to be obtained.

Implementing agencies

The watershed programme is being carried out in desert, drought prone and rainfed areas through DRDA/Zilla Parishad at the district level. Project implementation agency is also selected by DRDA / Zilla Parishad. However, other institutions like Integrated Tribal Development Agencies (ITDAs), agricultural universities, research institutions, government undertakings, non-governmental organisations etc. are also entrusted with some watershed projects for implementation. Not for profit organisations also take up independent work with supporting contribution from private sector.

Strategy for Soil and Water Conservation

The Division of Natural Resource Management (NRM) in DAC&FW, Government of India adopts micro-watershed as a basic unit of treatment with a view to developing the land resources under natural system in the catchments of River. The policy of the department is to treat the most vulnerable micro-watersheds on priority basis based on scientific data base, dissemination of data base to the implementing agencies and monitoring the progress of the developmental activities. The strategy adopted by the Department comprises:

- Dissemination and adoption of National Level Micro-Watersheds developed by dedicated organizations.

- Use of detailed scientific soil, land and water information generated on high spatial resolution for planning of vulnerable areas under watersheds.

- Integration of baseline survey maps for development of integrated action plan for development of each micro-watersheds.

- Awareness campaign and peoples' participation in watershed management.

- Evaluation of the impact of watershed development program.

Action Plan for Integrated Watershed Management

The Common Guidelines for Watershed Development Projects lay down a pragmatic approach to resolving issues of “institutional” versus “natural” boundaries by defining “operational watersheds” that align largely to village boundaries. This tactic - based on socially, politically, and/or administratively meaningful units—has been successfully applied. Since the watershed program is primarily a social program, and also because Village Watershed Committees (VWCs) within each Gram Panchayat are to be the ultimate implementing agency, the Guidelines offer a practical management solution.

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8. Rainfed Agriculture: challenges and strategies

Currently, the rainfed agriculture, which is totally rain dependent, accounts for 55 per cent of the net sown area of the country. Rainfed agriculture is crucial to country's economy and food security since it contributes to about 40 per cent of the total foodgrain production (85, 83, 70 and 65 per cent of nutri-cereals, pulses, oilseeds and cotton, respectively); supports two-thirds of livestock and 40 per cent of human population; further also influences livelihoods of 80 per cent of small and marginal farmers and is most vulnerable to monsoon failures. Even if full irrigation potential gets to be created, still 40 per cent of net cultivated area will remain as rainfed agriculture which would continue to be a major foodgrain production domain.

The Green Revolution in mid-sixties, though a boon to Indian agriculture at the macro level, it ushered in an era of wide disparity between productivity of irrigated and rainfed agriculture. It largely by-passed the rainfed agriculture including the eastern region of the country. Several development programmes were initiated for improving rainfed farming. The "Everything Everywhere" approach of taking up all major interventions uniformly across all regions of the country has not paid much dividend. The developmental approach in rainfed areas did not fully capture aspects like livelihood, soil resources, reliability of irrigation, socio-economic profile, infrastructure, etc. neglecting region-specific interventions befitting to the natural resource endowment, social capital, infrastructure and economic condition (NRAA, 2012). Rainfed agriculture is complex, diverse and risk prone. It is characterized by low levels of productivity and input usage coupled with vagaries of monsoon emanating from climate change, resulting in wide variation and instability in yields. In view of the growing demand for foodgrains in the country, there is a need to develop and enhance the productivity of rainfed areas. If managed properly, these areas have tremendous potential to contribute a larger share in food production and faster agricultural growth compared to irrigated areas which have reached a plateau. The state of rainfed agriculture is precarious and the problems associated with it are multifarious. To name the more striking ones: low cropping intensity, high cost of cultivation, poor adoption of modern technology, uncertainty in output, low productivity, increasing number of suicides among farmers, lack of institutional credit, inadequate public investment and high incidence of rural poverty (Singh et al., 2010).

The major challenge of rainfed agriculture in the decades to come will be sustaining the livelihoods of small and marginal farmers who will still depend on agriculture despite increased climate variability and shrinking land holdings.

Managing Risks: Key Issues

The rainfed agriculture is totally dependent on south-west monsoon and thus, is synonymous with risk due to erratic monsoon. A decrease of one standard deviation from the mean annual rainfall often leads to a complete loss of the crop. Dry spells of 2 to 4 weeks during critical crop growing stages cause partial or complete crop failure. Climate change and climate variability impacts Indian agriculture in general and more pronounced by the rainfed agriculture. The evident climate shifts in rainfed areas will have larger implications for crop planning, water resources assessment and prioritizing drought proofing programmes. Rainfed crops are likely to be worst hit by climate change because of the limited options for coping with variability of rainfall and temperature. The projected impacts are likely to further aggravate yield fluctuations of many crops with negative influence on food security and prices. Compound growth rates and instability index of major rainfed crops reveal that all the major crops registered negative growth in spite of the technologies such as new variety, fertilizers etc. The yield could not be increased significantly due to vagaries in monsoon and temperature, despite intervention through various governmental schemes.

Climatic risks like droughts and floods, and poor water and nutrient retention capacity of soil and low soil organic matter (SOM) impact negatively the rainfed agriculture. Risk is also to be addressed in terms of building resilience of crops, soils and farmers. Resilience to climate change will depend on increasing agricultural productivity with available water resources; refining technologies and timely deployment of affordable strategies to accomplish potential levels of arable land and water productivity. In this context, it seems rational for overall agricultural policy as well as the research system to prioritize issues related to resilience to climate risks, and strengthen the capacity of natural resources to overcome various forms of climate stress, as a critical requirement to achieve food security.

Environmental footprints of changing demand profile

With rising incomes, the demand for high energy food (milk, meat, eggs and oils) will increase. For instance, milk and meat demands in India by 2050 are estimated to be around 110 and 18.3 mt respectively. Such production levels could be attained by intensive animal rearing systems like semi- and stall-feeding; placing more demand for fodder, feed and water; and breed improvement. The projected domestic demand for different crop groups shows that rice and wheat may be surplus whereas other cereals will be in acute shortage (CRIDA Vision, 2015).

The deficit would be primarily for oilseeds, fruits, vegetables and pulses. Hence, the challenge would be to enhance productivity levels of these crops by promoting breeding programs and dryland horticulture. Further, as rice and wheat are going to be surplus, we need to follow a two-pronged strategy i.e. to increase their productivity by bridging the yield gaps and shifting some of the area under these crops to other cereals and vegetables through integrated farming systems approach which optimize the use of natural resources. Currently, there is an imbalance between natural resources endowment and cropping patterns in the country. It is an irony that areas with less rainfall are net exporters of agricultural produce to areas with sufficient rainfall and untapped groundwater potential (CRIDA Vision, 2015).

Strategies for Sustainable Agriculture in Rainfed Areas

- **I.** Enhancing and stabilising productivity
- **II.** Commodity crop specific strategies
- **III.** More crop and income per drop of water
- **IV.** Soil fertility management
- **V.** Quality seed production
- **VI.** Diversifying within farm
- **VII.** Dryland horticulture
- **VIII.** Alternate land use system

IX. Animal husbandry
X. Protected agriculture
XI. Fodder production
XII. Food processing & value addition
XIII. Farm mechanization

Strategies for increasing irrigated potential/area in rainfed areas are:

- Harvesting available water resources for stable irrigation.
- The groundwater potential in eastern region of the country is yet to be utilised rationally.
- Flood water management in north-eastern region
- Implementation & popularization of agro-ecology specific (soil & rainfall) in-situ moisture conservation practices.
- Mapping potential sites for rainwater harvesting in farm ponds.
- Popularization of farm pond technology package (selection of ideal site, digging, harvesting, lining, minimizing evaporation losses, lifting pump, micro-irrigation system)including efficient utilization of stored water for higher water productivity (More Crop and Income per Drop of Water).
- Desilting tanks to increase stored volume of water for irrigation of crops & groundwater stabilization.
- Adoption of water saving technologies viz., drip & sprinkler irrigation in commercial field & horticultural crops.
- Augmenting & popularization of use of treated waste-waters for irrigation.
- Popularization of recommended tank silt application in light textured soils

Government initiative

Climate change has already demonstrated its adverse impact on rainfed agriculture. The prevalence of extreme events and increased unpredictability of weather patterns can lead to reductions in production and lower incomes in these areas. Concerning the impact of climate change on rainfed agriculture, Government of India has emphasized on high priority on research and development to cope with climate change in agriculture sector.

Given the context, ICAR launched a mega project 'National Initiative on Climate Resilient Agriculture' (NICRA) to enhance the resilience of Indian agriculture, covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies; to demonstrate the site specific technology packages on farmers' fields for adapting to current climate risks; and to enhance the capacity of scientists and other stakeholders in climate resilient agricultural research and its application.

The thrust areas covered are, (i) identifying most vulnerable districts/regions, (ii) evolving crop varieties and management practices for adaptation and mitigation, (iii) assessing climate change impacts on livestock, fisheries and poultry and prioritising adaptation strategies.

Enhancing food security while contributing to mitigation of climate change and preserving the natural resource base and vital ecosystem services requires transition to agricultural production systems that are more productive, use inputs more efficiently, have less variability and greater stability in their outputs, and are more resilient to risks, shocks and long-term climate variability. More productive and more resilient agriculture requires a major shift in the way land, water, soil nutrients and genetic resources are managed to ensure that these resources are used more efficiently.

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9. Organic Farming

Organic agriculture is recognized as an innovative farming system, that balances multiple sustainability goals and will be of increasing importance in global food and ecosystem security (Reganold and Wachter, 2015). High demand for organic foods in Europe and North America has resulted in the import of organic foods from large farms. Organic agriculture relies on location specific varieties (resistant/tolerant to pest and diseases), crop rotation, organic composts, green manure, biological pest management and prohibits the use of synthetic fertilizers and pesticides, antibiotics, genetically modified organisms, and growth hormones. Concerns about the un-sustainability of conventional agriculture (based on synthetic inputs) have promoted interest in other farming systems, such as organic, integrated and conservation agriculture (CA).

Organic farming has the potential to produce high quality food, enhance natural resource base and environment, increase income (coming from premium price on the produce, even in the face of a slight dip in the yields) and contribute to the wellbeing of the farmers. Under extreme climatic conditions such as drought which are expected to increase with climate change, organically managed farms may produce higher yields than their conventionally managed farm due to improvement in soil properties (Das et al., 2016). Under severe drought conditions, which are expected to increase with climate change in many areas, organically managed farms have frequently been shown to produce higher yields than their conventionally managed farms due to the higher water-holding capacity of organically farmed soils (Siegrist et al., 1998). In addition, improvements in management practices and location specific crop varieties for organic systems may also narrow down this yield gap.

Organic and Towards Organic Agriculture

Organic farming is to create integrated, humane, environmentally and economically sustainable production systems, which maximize reliance on farm-derived renewable resources and the management of ecological and biological processes and interactions. The purpose is to realise acceptable levels of crop, livestock and human nutrition, protection from pests and disease, and an appropriate return to the human and other resources. Organic farming provides long-term benefits to people and the environment. There are two significant areas where organic systems have higher yields compared to conventional systems. These are:

- under conditions of climate extremes; and
- in small holder systems.

Both these situations are critical to achieving safe food security for future in India. Organic farmers grow a variety of crops and raise livestock in-order to optimize competition for nutrients. This results in less chance of low production, improved availability and positively impact local food security. Studies by national and international agencies have proved these positive aspects of organic agriculture systems.

Organic farming: concepts

The concept of organic farming is based on the following principles:

• Nature is the best role model for farming, since it does not use any input(s) nor demands unreasonable quantities of water.

• The entire system is based on intimate understanding of nature's ways. The system does not believe in mining of the soil of its nutrients and does not degrade it in any way for today's needs.

• The soil in this system is a living entity and the soil's living population of microbes and other organisms are significant contributors to its fertility on a sustained basis and must be protected and nurtured at all cost.

• The total environment of the soil, from soil structure to soil cover is more important.

Organic farming: focus

Organic agriculture is a holistic production management system which promotes and enhances health of the agro-ecosystem, including bio-diversity, biological cycles, and soil biological activity. Its emphasis is on the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, cultural, biological and mechanical methods, as opposed to using synthetic material, to fulfil any specific function within the system. Organic farming aims to optimize quality in all aspects of agriculture by taking into consideration the natural capacity of plants, animals and the land. It emphasizes on the health of agricultural ecosystem and prohibits the use of synthetic herbicides and pesticides, synthetic fertilizers in crop production and hormones antibiotics in livestock production, and genetically modified organisms. It respects the law of nature to increase yields and disease resistance. Organic farming requires a high level of farm management skills and demands use of wide range of resources to solve the problems. The organic farming focuses on:

• Maximization of biological activity in soils.

• Maintenance of long term soil health and minimization of soil erosion.

• Enhancing genetic and biological system and the surroundings.

• Raising of livestock with optimal living conditions for well -being and better health.

• Recycling of materials of plant and animal origins, nutrients to the soil.

• Minimization of the use of non-renewable resources.

Principles of organic farming

It aims to work as much as possible within a closed system, and draw upon local resources with a view to:

- maintain the long-term fertility of soils;
- avoid all forms of pollution that may result from agricultural techniques;
- produce foodstuffs of high nutritional quality and sufficient quantity;
- reduce the use of fossil energy in agricultural practice to a minimum;
- give livestock conditions of life that confirm to their physiological need; and
- make it possible for agricultural producers to earn a living through their work and develop their full human potential.

Various forms of Organic Agriculture

Bio-dynamic agriculture

Bio-dynamic agriculture is a method of farming that aims to treat the farm as a living system which interacts with the environment, to build healthy & living soil and to produce food that nourishes and vitalizes and helps to develop mankind. The underlying principle of biodynamics is making life-giving compost out of dead material. The methods are derived from the teachings of Rudolf Stainer and subsequent practitioners. These bio-dynamic preparations named BD-500 to BD-507 are not food for the plants, but they facilitate effective functioning of etheric forces. They are also not the usual compost starters, but can stimulate compost organisms in various ways. In short, they are biologically active dynamic preparations which help in harvesting the potential of astral and etheral powers for the benefit of the soil and various biological cycles in the soil. So far, 9 bio-dynamic preparations have been developed, named as formulations 500 to 508. Out of these, formulation-500 (cow horn compost) and formulation- 501 (horn-silica) are very popular and are being used by large number of organic farmers. Formulations-502 to 507 are compost enrichers and promoters, while formulation 508 is of prophylactic in nature and helps in control of fungal diseases.

Rishi krishi

Drawn from Vedas, the Rishi Krishi method of natural farming has been mastered by farmers of Maharashtra and Madhya Pradesh. In this method, all on-farm sources of nutrients including compost, cattle dung manure, green leaf manure and crop bio-mass for mulching are utilised to their best potential with continuous soil enrichment through the use of Rishi Krishi formulation known as "Amritpani" and virgin soil. A quantum of 15 kg of virgin rhizosperic soil collected from beneath the banyan tree (Ficus bengalensis) is spread over one acre and the soil is enriched with 200 lit Amritpani. It is prepared by mixing 250 g ghee into 10 kg of cow dung followed by 500 g honey and diluted with 200 lit of water. This formulation is utilized for seed treatment (beejsanskar), enrichment of soil (bhumisanskar) and foliar spray on plants (padapsanskar). For soil treatment it is need to be applied through irrigation water as fertigation. The system has been demonstrated on a wide range of crops i.e. fruits, vegetables, cereals, pulses, oilseeds, sugarcane and cotton.

Panchgavya krishi

Panchgavya is a special bio-enhancer prepared from five products - cow dung, urine, milk, curd and ghee. The cost of production of panchgavya is about Rs. 25-35 per lit. Panchgavya contains many useful micro-organisms such as fungi, bacteria, actinomycetes and various micronutrients. The formulation acts as a tonic enriching the soil, inducing plant vigour with quality production.

Natural farming

Natural farming that goes beyond organic farming, emphasizes on efficient use of on-farm biological resources and enrichment of soil with the use of Jivamruta (fermented microbial culture used for soil enrichment) to ensure high soil biological activity. Use of Bijamruta (fermented microbial culture used for soil enrichment) for seed/ planting material treatment and Jivamruta for soil treatment and foliar spray are important components of natural farming. Jivamruta has been found to be rich in various beneficial micro-organisms. One application in one acre requires 200 litres of jivamruta. It can be applied through irrigation water by flow, by drip or sprinkler or even by drenching of mulches spread over the field or under the tree basin.

Natu-eco farming

The Natu-eco farming system follows the principles of eco-system networking of nature. It goes beyond the broader concepts of organic or natural farming in both philosophy and practice. It offers an alternative to the commercial and agro-chemical intensive techniques of modern farming. Instead, the emphasis is on the simple harvest of sunlight through the critical application of scientific examination, experiments, and methods that are rooted in the neighbourhood resources. It depends on developing a thorough understanding of plant physiology, geometry of growth, fertility, and biochemistry. Natu-eco Farming emphasizes `Neighbourhood Resource Enrichment' by `Additive Regeneration' in preference to dependence on external commercial inputs.

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10. Integrated Farming System

Integrated farming system (IFS) is an entire complex of development, management and allocation of resources as well as decisions and activities, within an operational farm unit, or combinations of units, that result in agricultural production, processing and marketing of the products. IFS is a whole farm management approach that combines the ecological care of a diverse and healthy environment with the economic demands of agriculture to ensure a continuing supply of wholesome, and affordable food. It is a dynamic concept which must have the flexibility to be relevant on any farm, in any country, and it must always be receptive to change and technological advances. Above all, IFS is a practical way forward for agriculture that will benefit the society, not just those who practise it. IFS can be defined as a positive interaction of two or more components of different nature like crops, livestock, fishery, trees etc. within the farm to enhance productivity and profitability in a sustainable and environmentally friendly way. A judicious mix of two or more of these farm enterprises with advanced agronomic management tools may compliment the farm income together with help in recycling the farm residues. The selection of enterprises must be based on the cardinal principles of minimizing the competition and maximizing the complementarity between the enterprises. In general, farming system approach is based on the following objectives:

- Sustainable improvement of farm household systems involving rural communities
- Farm production system improvement through enhanced input efficiency
- Raising the family income
- Satisfying the basic needs of farm families
- Minimising the risk that comes from a single activity

Farming System Steps

Embedded in general principle is an essential five-step procedure for farming system research and adoption.

Classification: Classification is concerned with the geo-referenced identification of homogenous group of farmers with similar natural and socio-economic characteristics. It forms the basis for the setting of priorities and for targeting of research and extension to particular farm types.

Diagnosis: Diagnosis has to do with identifying the limiting factors, constraints and development opportunities of particular target farm types.

Experimentation and recommendation: Recommendations made from the knowledge, but in field situations which involves experimentation, either at the farm level or at the research station or at both, as a pre-requisite.

Implementation: Implementation commitment is usually found in farming systems programs directly through support to the extension agencies.

Evaluation: Evaluation is an important component and will lead to reappraisal, preferably on GPS location basis.

Farming Systems Typology

An analysis of benchmark data of 732 number of marginal households across the 30 NARP (National Agricultural Research Project) zones indicates existence of 38 types of farming systems. Of these, 47 per cent of households have adopted integration of crop + dairy, 11 per cent crop + dairy + goatery, 9 per cent crop + dairy + poultry systems and 6 per cent households have only crop component. In terms of number of components integrated by marginal households, 52 per cent households practise only two components while 7 per cent do only one component. The remaining 41 per cent households have components ranging from 3 to 5. There exists scope in the case of 59 per cent of marginal households for integration of allied enterprises for improving the per capita income. Though, the mean holding and family size of marginal households practising upto 2 or more components remains almost same (0.82 ha with 5 no's in 2 component category; and 0.84 ha with 5 no's in > 2 component category), the mean income level is much higher (Rs.1.61 lakh) in case of farms having more than 2 components (e.g., crop + dairy + goatery; crop + dairy + goatery + poultry; crop + dairy + goatery + poultry + fish etc.) in comparison to farms having 2 or less components (Rs.0.57 lakh only in crop alone, dairy alone, crop + dairy, crop + goatery etc.). Diversification of one and two component systems (crop alone, dairy alone, crop + dairy, crop + piggery, crop + poultry, crop + fisheries, crop + horticulture, crop + goatery, dairy + goatery) in the case of 59 per cent marginal household is essential to augment the per capita income.

Farm Diversification under Extreme Weather Situations

The national trends indicate that the non-vegetarian population is increasing over the years and this trend is likely to persist. Therefore, the demand for livestock and fishery products can be expected to increase in future. The traditional system of sole crop or cropping system as prevailing is not sufficient to meet the food and nutritional needs of small households. Diversification is considered to be a good alternative to improve system yield with enhanced profitability. The farming system approach takes into account the components of soil, water, crops, livestock, labour, capital, energy and other resources, with the farm family at the centre managing agricultural and related activities, and is highly location specific in nature. There are two approaches of farming systems, namely, holistic and innovative. The holistic approach deals with improving the productivity of existing components in totality, while innovative approach aims at improving the profitability of existing farming systems. However, a farm family functions within the limitations of its capacity and resources, socio-cultural setting etc. Since small farms are often vulnerable to natural vagaries like flood & drought, farming remains at risk. With increasing population and competing demand from industries and urbanisation, horizontal expansion of agricultural area is not possible. However, vertical expansion of small farms is possible by integrating appropriate farming system components and generating additional space and scope for activities, jobs and income.

Cropping System as a Tool to Enhance Farmers' income

Crops and cropping systems with differential behaviour and requirement provide newer challenge as well as opportunity for management to achieve higher productivity of input like water and nutrients.

More than 250 double cropping systems are followed throughout the country, amongst which 30 have been identified for irrigated conditions. These systems are rice-wheat, rice-rice, rice-gram, rice-mustard, rice-groundnut, rice-sorghum, pearl millet-gram, pearl millet-mustard, pearl millet-sorghum, cotton-wheat, cotton-gram, cotton-sorghum, cotton-safflower, cotton-groundnut, maize-wheat, maize-gram, sugarcane-wheat, soybeanwheat, sorghum-sorghum, groundnut-wheat, sorghum-groundnut, groundnut-rice, sorghumwheat, sorghum-gram, pigeon pea-sorghum, groundnut-groundnut, sorghum-rice, groundnutsorghum and soybean-gram. However, the systems that are considered to be the major contributors to national food basket are: rice (Oryza sativa L.)-wheat (Triticum aestivum L. emend. Fiori & Paol.) (10.5 million ha), rice-rice (5.9 million ha) and coarse grain (now renamed as nutri-cereals) based systems (10.8 million ha).

Specific Strategies for Sustainability of Integrated Farming Systems

Integrated farming systems for different zones

The concepts associated with IFS are practised by numerous farmers across the globe. A common characteristic of these systems is, that they invariably have a combination of crop and livestock enterprises and in some cases may include combinations of aquaculture and trees. Water storage structure will be central to all the farming activities. Suggested IFS for different zones in India (Jayanthi et al. 2002) are given below:

High altitude cold desert: Pastures with forestry, sheep, goats, rabbits, and yak along with limited crops like millets, wheat, barley, vegetables and fodders.

Arid and desert regions: Animal husbandry with camels, sheep and goat with moderate crop component involving pearl millet, wheat, pulses, oil seeds and fodders.

Western and Central Himalayas: Emphasis on horticultural crops with crops like maize, wheat, rice, pulses and fodders on terraces, pastures with forestry, poultry, sheep, goats, rabbits, and yak (at altitudes above 2,500 m amsl).

Eastern Himalayas: Horticultural crops with crops like maize, wheat, rice, pulses and pasture on terraces, pastures with forestry, sheep, goats, rabbits, yak and cold water fisheries at altitudes above 2000 m amsl. Maize, rice, french bean, ricebean, piggery, poultry, fishery and cole crops above 1000 m amsl. Rice, pulses, dairying, fish culture, vegetables in case of less than 1,000 m amsl.

Indo-Gangetic Plains: Intensive crop husbandry involving rice, maize, wheat, mustard and pulses and dairy.

Central and southern highlands: Crops such as millets, pulses, and cotton along with dairy cattle, sheep, goat and poultry.

Western Ghats: Plantation crops, rice and pulses as also livestock components including cattle, sheep and goats.

Delta and coastal plains: Rice and pulse crops along with fish and poultry.

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Agriculture

Chapter 6

Short Answers

CSM-05: Compiled by Prof. Ashok Vishandass

22

This chapter contains:

- Good Agricultural Practices
- Secondary Agriculture
- Avenues in Secondary Agriculture
- Agro-processing Industry Development
- Programmes for New Skills and Upskilling
- Operationalising Secondary Agriculture
- Beekeepin
- Lac Cultivation as an Enterprise
- Agro-forestry
- Bamboo as a Component of Secondary Agriculture

Contents

1. Good Agricultural Practices

The Food and Agricultural Organization (FAO) of the United Nations uses Good Agricultural Practice (GAP) as a collection of principles to apply for on-farm production and postproduction processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economic, social and environmental sustainability. These four 'pillars' of GAP (economic viability, environmental sustainability, social acceptability, and food safety & quality) are included in most private and public sector standards, but the scope which they actually cover varies widely. The concept of Good Agricultural Practices (GAPs) has evolved in recent years in the context of a rapidly changing and globalizing food economy, and as a result of the concerns and commitments of a wide range of stakeholders about food production and security, food safety and quality, and the environmental sustainability of agriculture. A broadly accepted approach using GAP principles, generic indicators and practices will help guide the debate on national policies, actions and preparation of strategies, so as to ensure that all stakeholders benefit from the application of GAP in the food chain. The implementation of GAP should therefore contribute to Sustainable Agriculture and Rural Development (SARD). Its broad objectives are:

- Ensuring safety and quality of produce in the food chain.
- Capturing new market advantages by modifying supply chain governance.
- Improving natural resources use, workers' health and working conditions; creating new market opportunities for farmers and exporters in developing countries.

Key Elements of GAP

Some key elements are as follows:

- Prevention of problems before they occur
- Risk assessment
- Commitment to food safety at all levels
- Communication through the production chain
- Mandatory employee education program at the operational level
- Field and equipment sanitation
- Integrated pest management
- Oversight and enforcement
- Verification through independent, third-party audits

Potential Benefits of GAP

Some identified positive outcomes are listed below:

- Appropriate adoption and monitoring of GAP helps to improve the safety and quality of food and other agricultural products.

- It may help to reduce the risk of non-compliance with national and international regulations, standards and guidelines and the International Plant Protection Convention (IPPC) in relation to permitted pesticides, maximum levels of contaminants in food and non-food agricultural products, as well as other chemical, micro-biological and physical contamination hazards.

- Adoption of GAP helps to promote sustainable agriculture and contribute to meeting national and international environment and social development objectives.

Challenges related to GAP

Some of the challenges are as follows:

- In some cases, GAP implementation and especially record keeping and certification increases production costs. In this respect, lack of harmonization between existing GAP-related schemes and availability of affordable certification systems has often led to increased confusion and certification costs for farmers and exporters.

- There is a high risk that small scale farmers will not be able to seize export market opportunities unless they are adequately informed, technically prepared and organized to meet this new challenge, with governments and public agencies playing a facilitating role.

- Compliance with GAP standards does not always foster all the environmental and social benefits, as claimed.

- Need for creating awareness about 'win-win' practices that will bring about improvements in yield and production efficiencies, as well as environment and health and safety of workers. One such approach is Integrated Production and Pest Management (IPPM).

Good Agricultural Practices for selected Agricultural Components

Soil

- Appropriate soil management aims to maintain and improve soil productivity by improving the availability and plant uptake of water and nutrients through enhancing soil biological activity, replenishing soil organic matter and soil moisture, and minimizing losses of soil, nutrients, and agro-chemicals through erosion, run-off and leaching into surface or ground water.

- Good practices related to soil include maintaining or improving soil organic matter through the use of soil carbon-build up by appropriate crop rotations, manure application, pasture management and other land use practices, rational mechanical and/or conservation tillage practices; maintaining soil cover to provide a conducive habitat for soil biota, minimizing erosion losses by wind and/or water;

and application of organic and mineral fertilizers and other agro-chemicals in amounts and timing and by methods appropriate to agronomic, environmental and human health requirements.

Water

• Agriculture carries a high responsibility for the management of water resources in quantitative and qualitative terms, since it is using more than 80 per cent of the utilisable water in the country. Careful management of water resources and efficient use of water for rainfed crop and pasture production, for irrigation where applicable, and for livestock, are criteria for GAP. Efficient irrigation technologies, as also new generation technologies like sensors and management will minimize waste and will avoid excessive leaching and salinization.

• Good practices related to water will include those that maximize water infiltration and minimize unproductive efflux of surface waters from watersheds; manage ground and soil water by proper use, or avoidance of drainage where required; improve soil structure and increase soil organic matter content; apply production inputs, including waste or recycled products of organic, inorganic and synthetic nature by practices that avoid contamination of water resources; adopt techniques to monitor crop and soil water status, accurately schedule irrigation, and prevent soil salinization by adopting watersaving measures.

Crop and fodder production

• Crop and fodder production involves the selection of annual and perennial crops, their cultivars and varieties, to meet local consumer and market needs according to their suitability to the site and their role within the crop rotation for the management of soil fertility, pests and diseases, and their response to available inputs. Perennial crops are used to provide long-term production options and opportunities for inter-cropping. Annual crops are grown in sequences, including those with pasture, to maximize the biological benefits of interactions between species and to maintain productivity. Harvesting of all crop and animal products removes their nutrient content from the site and must ultimately be replaced to maintain long-term productivity.

• Good practices related to crop and fodder production will include those that select cultivars and varieties on an understanding of their characteristics, including response to sowing or planting time, productivity, quality, market acceptability and nutritional value, disease and stress resistance, edaphic and climatic adaptability, and response to fertilizers and agrochemicals; devise crop sequences to optimize use of labour and equipment and maximize the biological benefits of weed control by competition, mechanical, biological and herbicide options, provision of non-host crops to minimize disease and, where appropriate, inclusion of legumes to provide a biological source of nitrogen; apply fertilizers, organic and inorganic, in a balanced fashion, with appropriate methods and equipment and at adequate intervals to replace nutrients extracted by harvest or lost during production. The safety regulations and established safety standards for the operation of equipment and machinery for crop and fodder production are needed for GAP.

Crop protection

• Maintenance of crop health is essential for successful farming with respect to both yield and quality of produce. This requires long-term strategies to manage risks by the use of disease- and pest-resistant crops, crop and pasture rotations, disease breaks for susceptible crops, and the judicious use of agro-chemicals to control weeds, pests, and diseases following the principles of Integrated Pest Management.

• Good practices related to crop protection will include those that use resistant cultivars and varieties, crop sequences, associations, and cultural practices that maximize biological prevention of pests and diseases; maintain regular and quantitative assessment of the balance status between pests and diseases and beneficial organisms of all crops; adopt organic control practices where and when applicable; apply pest and disease forecasting techniques where available; determine interventions following consideration of all possible methods and their short- and long-term effects on farm productivity and environmental implications in order to minimize the use of agrochemicals, in particular to promote integrated pest management (IPM). It is to ensure that agro-chemicals are only applied by specially trained and knowledgeable persons and accurate records of agrochemical use is maintained.

Animal production

• Livestock require adequate space, feed, and water for their welfare and productivity. Stocking rates must be adjusted and supplements provided as needed to livestock grazing pasture or rangeland. Chemical and biological contaminants in livestock feeds are avoided to maintain animal health and/or to prevent their entry into the food chain.

• Good practices related to animal production will include those that site livestock units appropriately to avoid negative effects on the landscape, environment, and animal welfare; avoid biological, chemical, and physical contamination of pasture, feed, water, and the atmosphere; frequently monitor the condition of stock and adjust stocking rates, The minimum use of the non-therapeutic use of antibiotics; integrate livestock and agriculture to avoid problems of waste removal, nutrient loss, and greenhouse gas emissions by efficient recycling of nutrients are important GAP.

Animal health and welfare

• Successful animal production requires attention to animal health, that is maintained by proper management and housing, by preventive treatments such as vaccination, and by regular inspection, identification, and treatment of ailments, using veterinary advice as required.

• Good practices related to animal health and welfare will include those that minimize risk of infection and disease by good pasture management, safe feeding, appropriate stocking rates and good housing conditions; keep livestock, buildings and feed facilities clean and provide adequate, clean bedding where livestock is housed; ensure staff are properly trained in the handling and treatment of animals; seek appropriate veterinary advice to avoid disease and health problems;

ensure good hygiene standards in housing by proper cleansing and disinfection; treat sick or injured animals promptly in consultation with a veterinarian.

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2. Secondary Agriculture

Strictly speaking, the preface "secondary" to any activity, is used to typically imply the next step or higher level of operations – for example, secondary education in school, or secondary processors in computers, or secondary processing in the agro-processing sector, etc. The term secondary agriculture would therefore indicate and refer to an elevated level of agricultural operations, or those linked to agricultural activities. However, it is observed that the term 'secondary agriculture' is mainly non-existent around the world, and even then, where it finds limited use, the term is understood differently.

In the United States, the types of operations in "primary" and "secondary" agriculture are categorised: Primary agriculture is cultivation and tilling of soil, and growing and harvesting any agricultural commodity. Secondary agriculture is "performed either by a farmer or on a farm as an incident to or in conjunction with 'such' farming operations." It includes "assembling, ripening, cleaning, grading, sorting, drying, preserving, packing, and storing" fruits and vegetables, but does not include processing of fruits and vegetables from their natural state. This definition excludes all processing activities from being called secondary agriculture. This is similar to how India differentiates between agricultural produce viz an agricultural product for taxation purposes. In the EU, the term secondary agriculture is not used and the EU economic accounts for agriculture (EEAA) include the related service activities as part of the agricultural sector. The United Nations Statistics Divisions, that classifies various economic activities, does not define secondary agriculture.

In India, 'secondary agriculture' is spoken of, but is not clearly defined, though it is commonly used to identify the agro-based manufacturing sector. The Planning Commission of India had constituted a Technical Advisory Committee on Secondary Agriculture (TACSA) in 2007. The TACSA submitted its report in October 2008, but did not define the term 'secondary agriculture'. Instead it states that the term "is very broad as it includes all food and non-food bio-resource-based products for human and industrial use". The term is seen to be used as an omnibus expression to relate to the product of agro-based processing activities of the secondary sector. Effectively, TACSA detailed the output from the activities to explain the term "secondary agriculture". In fact, by correlating secondary agriculture to all food and non-food products it seems the term would encompass all types of industries as long as its input is a bioresource – making secondary agriculture another terminology for all kinds of agro-industry.

As agriculture develops as an enterprise, the farmer(s)' enterprise will constitute an output supply chain and such an entity(ies) can no longer be exclusively seen to belong to the primary activity of cultivation. As farmers' enterprises develop, we get to see that the agricultural output, is communicated to consumers, while still under ownership of the producer (FPO), utilising secondary or tertiary sector activities, which are managed by the FPO itself.

There is the need to understand and add clarity on the operational framework of the various secondary level activities in agriculture from the perspective of farmers and farming households. This is essential as farmers expand their works beyond cultivation and harvesting.

Operational framework of secondary agriculture

In a scenario wherein the per-capita income of a rural household is less than that of urban household, especially in the age of booming e-commerce, the increasing flow of money from rural to urban areas is a cause for concern. The need is to transform the situation from 'rural people as consumers of industrial goods' to 'rural people as producers of industrial grade output, especially the population related to farming. Secondary Agriculture in such a case is expected to bring about a shift in the direction of flow of money from urban to rural areas, especially through meeting the demand for value addition or pre-conditioning services from the food processing industries in urban areas.

This gap is envisioned to be filled through a fresh emphasis on Secondary Agriculture by complementing the rural household incomes as against efforts of shifting the manpower from farm to non-farm domains, which is not easy to come by.

Defining Secondary Agriculture

The DFI Committee feels that instead of defining Secondary Agriculture2 by its possible products, it will be more appropriate to define it by the resources its utilises, the scope of involvement of the agricultural community, the type of technology it deploys, and the scale of the activity. As such, for an activity to be called secondary agriculture, it must be an enterprise that has direct involvement of the agricultural community and must provide growth opportunity to the primary sector. Secondary level activities, linked to agriculture, can include economic activities from the secondary or the tertiary sectors.

It is important to delineate the various productive activities, keeping in perspective the national agenda of doubling farmers' income, promoting farmer(s) owned enterprise, and enhancing rural employment & farm household income. Such economic activities would preferably not be of capital intensive category, be labour intensive, utilise products or by-products from farming and other rural resources, be of operational and technological scale that can be opted for, at village level, and finally enhances wealth creation at rural level.

Special Support to Secondary Agriculture

Secondary agriculture may be considered for special support, such as

a. Priority sector status for institutional credit.

b. Low cost skilling and knowledge based exposure.

c. Specialised extension services for enterprises owned by females.

d. Priority under rural electrification objectives.

e. Fast track procedures to avail benefits under ongoing central sector and centrally supported schemes.

f. Geographical Indicator labels to products from village scale secondary production.

Secondary agriculture would need to be promoted by providing enterprise level support, which can be undertaken by initial setting up of a Division on Secondary Agriculture & Enterprises in all three Departments of the Ministry of Agriculture and Farmers' Welfare, and coordinate their efforts through a structured platform.

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3. Avenues in Secondary Agriculture

Prior to the identification of various avenues of Secondary Agriculture in India, there is need to discuss various push and pull factors that prompt the shifts to complement the income generation activity at village level. On one front, the emerging exodus of manpower from agriculture without its matching absorption into the manufacturing and service industries, triggers a need to provide alternative income generation opportunities in rural India calling for immediate focus on Secondary Agriculture (see definition and explanation in Chapter 1). On the other front, the rising per capita income of urban and rural India, changing consumption patterns, competition in international markets, technology enabled linkages between the production centres and the food processing industries and increasing awareness & regulations on food safety standards are prompting changes in the production systems of agriculture and allied sectors. A conscious effort to bridge these two situations would serve the intended purpose of generating additional employment and income within the rural segment, and check avoidable migration, particularly distress migration.

Exodus of manpower from agriculture is widely reported and is considered as an indicator of development. It may not always to be correct to interpret this way, for there can be distress migration even when the alternate sectors of the economy are not prepared for such an absorption. Along with movement of manpower away from agriculture, its decreasing ratio of contribution to GDP is also considered as a parameter of development based on western models of economic growth. As manufacturing and service sectors mature in a traditional economy, the share of primary sector (agriculture) is seen to reduce. However, its contribution in terms of absolute numbers may be growing and it is essential to ensure this . More importantly, there is need to examine how primary and secondary agriculture can be modelled to generate productive employment and income opportunities, and this is critical in the context of India's high population density.

It would also be useful to note, that relative to other comparable poor/emerging economies, India's emphasis on tertiary education, emphasis on capital goods production capability, especially through public-sector involvement, labour laws may have limited India's growth in labour intensive manufacture. In the cases of fast growing states within the country, viz., Tamil Nadu, Karnataka, West Bengal, Delhi, and Maharashtra, the growth path has skipped the pathway of labour-intensive industries to opt for specialisation in skill-intensive industries (within manufacturing). This scenario of missing labour-intensive growth and adoption of higher skill-intensive growth has a significant bearing on the employment of manpower exiting from agriculture sector. It is in this context, that Secondary Agriculture deserves the attention in recognition of its ability to offer in situ gainful employment opportunities. The twin advantages of such an approach are (i) avoidance of distress migration; and (ii) non-farm income avenues adding to farmer's income kitty.

Trends in Agriculture Markets and Emerging Opportunities

Agriculture export as share of total Indian exports has not improved much over the decades since liberalisation. Between 1991-92 and 2010-11, the proportion of Agriculture Exports to Total Exports improved from 1:5 to 1:8 in favour of non-agricultural exports. However, the growth of agriculture exports has not increased substantially given the need to feed the growing population.

Interestingly, the liberalisation and various trade agreements between India and other countries paved the way for greater opening up of the markets. This trend has resulted in the need for stringent adherence to quality standards in terms of grades & standards, inert material, chemicals used in production / protection from diseases and pests, harvesting & storage practices, etc,. Indian production and post-production handling systems are yet to change in response to the global destination markets.

Several initiatives of the Government to improve the market infrastructure and systems are nudging for increased alignment of production for national and international markets. The growing trends of e NAM (electronic National Agricultural Market), trading of agriculture commodities on electronic exchanges, use of expanding warehousing infrastructure is aiding standardisation of agriculture commodities for trading / marketing purposes.

The Avenues

Broadly, the avenues of Secondary Agriculture can be categorised into three types:

- Type A: Value addition to Primary Agriculture Production Systems
- Type B: Alternative Enterprises
- Type C: Enterprises that use crop residues and wastes of Primary Agriculture

Women in Agriculture and Micro-enterprises

Women make substantive contributions to all the agricultural activities encompassing crop production, dairying, animal husbandry and fisheries. Their engagements are visible across the value chain. It must be appreciated, that they do this along with their responsibilities as home makers. The art and science of multi-tasking that women possess is invaluable. Men in comparison are not par the course. Yet, the contributions of women go unheard, untold and unsung. Rendering the situation more sordid, there is so much needed to be done to give them the social status that is rightfully theirs.

Women can become exemplary micro-entrepreneurs, only if their innate talents are made professional through appropriate training to link up with markets and meet the laid down standards. As entrepreneurs, they will come to handle the money directly and claim the rightful position at home and in society.

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4. Agro-processing Industry Development

Secondary agriculture as village and cottage enterprise units is discussed, that create employment and help capture value for the actors traditionally employed in the primary sector. However, the entire agro-processing sector sources its raw materials from the primary sector, and except for the aspects of size and technology, the units categorised as secondary agriculture, are essentially a part of the umbrella category defined as the secondary sector economic activity.

In the secondary sector, besides secondary agriculture units, there is also the need to develop large industrial scale units. The key qualifier for such units, would be their large capacity, and their greater reliance on capital intensive and automated technologies. The agenda would not be as much to generate jobs for rural manpower, but to optimise on the harvests and to lead to more sustainable use of resources output, food and non-food, from the varied agricultural production in the country. For example, castor oil extraction units, ethanol and bio-diesel units, enzyme and biological extraction industry, and all other high technology agro or bio-processing industries.

The sheer scale of such industrial units requires that they are designed and planned to receive regular feedstock, which may not necessarily be a locally available resource. These industrial units would not be cottage scale, and essentially may require very highly skilled employees such as chemical engineers, scientists, etc. for their operations. Nevertheless, current day technologies and future developments, will allow such industries to provide human civilization more healthy and sustainable living standards.

Present day Agro-based Industries in India

The agro-based industries probably constitute the oldest industrial development initiatives having arisen alongside agriculture. The earliest examples would be wool and leather based manufacturing, fibres into textiles, pigment extracts, medicinal extracts, beverages, flour milling, etc. In all probability the non-food processing sector developed earlier to the food processing sector.

The raw food was most likely processed individually in family kitchens, before such cooking or food preparation was taken up as an economic activity at enterprise scale. Raw food was also used as a barter to exchange for the other products of industry.

The future of the agro-based industries is bright, even though some agro-based products may have been replaced with industrial materials like plastics and polymers. However, a renewed consciousness to lower the ecological footprint and new technologies have allowed for resurgence of bio-based products, such as biodegradable plastics, bio based fuels and bio-based construction materials.

The potential of many agro-based industries have not been fully explored in India. The country can do well to develop industries that output tertiary and high technology products, using the 1.1 billion tonnes of agricultural produce within the country. All such development should be market linked to avoid post production losses of the manufactured product.

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5. Programmes for New Skills and Upskilling

Given that human power, is the major asset that obtains in the agriculture sector, creating a skilled workforce is fundamental to realise manpower productivity. Agriculture domain has witnessed several capacity building/skill building initiatives in the past. With modest agriculture growth, there is a clear need for a shift towards appropriate skill development. The secondary sector, like all other manufacturing industries, relies on a mix of highly skilled and medium skilled work force. Within the secondary sector, the units that are defined as secondary agriculture, would also require certain specialised knowledge and skills in their operations. Though secondary agriculture is being defined as units that are less capital intensive in production and are comparatively more labour intensive, the workforce would require understanding of matters related to the handling of raw material and the transforming or manufacturing operations related thereto, as well as safety and quality aspects as per the needs of each type of unit.

Further, technology involved is no longer static and as new technologies are developed for these activities, regular updating and upgradation of skills can also be an expected demand. The content below discusses various active schemes/ programs, their salient features and various means of enlisting them for promoting secondary agriculture, with a view to impart value to the farmers' slack time with job avenues.

Government Schemes and Promoting Secondary Agriculture

Some of the schemes are discussed below:

Name of Scheme: Pradhan Mantri Fasal Bima Yojna (PMFBY)

Department: Department of Agriculture, Cooperation and Farmers' Welfare (Ministry of Agriculture & Farmers Welfare)

Salient features:

- To provide insurance coverage and financial support to the farmers in the event of failure of any of the notified crop as a result of natural calamities, pests & diseases.
- To stabilize the income of farmers and ensure their continued engagement in farming.
- To incentivize farmers to adopt innovative and modern agricultural practices by derisking them.
- To ensure flow of credit to the agriculture sector by incentivizing the institutional credit system.

Name of Scheme: Market Intervention Scheme (MIS) and Price Support Scheme(PSS)

Department: Department of Agriculture, Cooperation and Farmers' Welfare (Ministry of Agriculture & Farmers Welfare)

Salient features:

• To protect the growers of these horticultural/agricultural commodities from making distress sale in the event of bumper crop during the peak arrival period when prices fall to very low level. Thus it provides remunerative prices to the farmers in case of glut in production and fall in prices.

Name of Scheme: Pradhan Mantri Krishi Sinchai Yojana (PMKSY)

Department: Department of Agriculture, Cooperation and Farmers' Welfare (Ministry of Agriculture & Farmers Welfare)

Salient features:

• To attract investments in irrigation system at field level, develop and expand cultivable land in the country, enhance ranch water use in order to minimize wastage of water, enhance crop per drop by implementing water-saving technologies and precision irrigation.

Name of Scheme: Rashtriya Krishi Vikas Yojna (RKVY)

Department: Department of Agriculture, Cooperation and Farmers' Welfare (Ministry of Agriculture & Farmers Welfare)

Salient features:

• To ensure the preparation of Agriculture Plans for the districts and the states based on agro-climatic conditions, availability of technology and natural resources

• To ensure that the local needs/crops/ priorities are reflected in the agricultural plans of the States.

• To provide backward and forward infrastructure needed to promote production and marketing.

Name of Scheme: National Project on Organic Farming and Paramparagat Krishi Vikas Yojana

Department: Department of Agriculture, Cooperation and Farmers' Welfare (Ministry of Agriculture & Farmers Welfare)

Salient features:

• To promote organic farming practices as an option for sustainable agriculture and to ensure effective utilization of farm resources

• To offer financial and technical support for setting up of organic input production units such as fruits and vegetable market waste compost, bio-fertilizers and bio-pesticides and vermin-culture hatcheries.

• Human resource development and awareness creation and market development for quality control of organic inputs. (Department of Agriculture & Cooperation and Department of Animal Husbandry, Dairying & Fisheries)

Name of Scheme: National Project On Soil Health and Fertility

Department: Department of Agriculture, Cooperation and Farmers' Welfare (Ministry of Agriculture & Farmers Welfare)

Salient features:

- Strengthening of Soil Testing Laboratories (STLs)

- Promoting use of Integrated Nutrient Management

- Balanced use of fertilizers

Name of Schemes: Pandit Deendayal Upadhyay Unnat Krishi Shiksha Scheme

Department: Department of Agriculture, Cooperation and Farmers' Welfare (Ministry of Agriculture & Farmers Welfare)

Salient features: To provide complete knowledge and skill on processing, value addition and marketing of coconut and banana products through capacity building programmes involving research and development organizations.

Name of Scheme: National Project on Agro-forestry

Department: Department of Agriculture, Cooperation and Farmers' Welfare (Ministry of Agriculture & Farmers Welfare)

Objectives:

- Establishment of a National Agro-forestry Mission/Agro-forestry Board to implement the national policy by establishing coordination and synergy among various stakeholders.

- Enhancing farm productivity, incomes and livelihood opportunities of rural households, particularly of the small holder farmers through agroforestry.

- To meet the increasing demand for timber, food, fuel etc.; conservation of natural resources, protection of environment and increasing forest cover etc.

- Special focus on bamboo as agro-forestry intervention for selected areas (north east, eastern states etc.) following the budget pronouncement for a re-structured National Bamboo Mission with an outlay of Rs. 1290 crore to promote bamboo sector in a holistic manner.

Name of Scheme: National Mission on Horticulture

Department: Department of Agriculture, Cooperation and Farmers' Welfare (Ministry of Agriculture & Farmers Welfare)

Salient features:

- To provide holistic growth of the horticulture sector through an area based regionally differentiated strategies

• To enhance horticulture production, improve nutritional security and income support to farm households

• To establish convergence and synergy among multiple on-going and planned programmes for horticulture development

• To promote, develop and disseminate technologies, through a seamless blend of traditional wisdom and modern scientific knowledge

• To create opportunities for employment generation for skilled and unskilled persons, especially unemployed youth

Name of Scheme: National Skill Development Mission (NSDM)

Department: Ministry of Skill Development and Entrepreneurship (MSDE)

Salient features:

• To rapidly scale up skill development efforts in India, by creating an end-to-end, outcome-focused implementation framework, which aligns demands of the employers for a well-trained skilled workforce with aspirations of Indian citizens for sustainable livelihoods.

Name of Scheme: National Apprenticeship Promotion Scheme (NAPS)

Department: Ministry of Skill Development and Entrepreneurship (MSDE)

Salient features:

• Sharing of stipend with employers to a maximum limit of Rs. 1,500 per month per apprentice.

• Sharing of Basic Training Cost with Basic Training Providers to a maximum limit of Rs. 7,500 for 500 hours/ 3 months per apprentice.

Name of Scheme: Deendayal Upadhyay Swaniyojan Yojana (DUSY)

Department: Ministry of Rural Development

Salient features:

• To provide skill sets for self-employment to rural masses

• To give incentives to rural poor pursuing self-employment

• To provide financial assistance to self-employed or poor rural entrepreneurs

• To support poor rural people desirous of starting new business or pursuing selfemployment options

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6. Operationalising Secondary Agriculture

It would be important to delineate specific avenues and activities, that can promoted as enterprises under Secondary Agriculture. It can be one of these:

A. Value addition to primary agriculture production systems.

B. Alternative enterprises.

C. Enterprises that strive on crop residues and wastes of primary agriculture

Level of Enterprises

The primary focus of secondary agriculture in the context of small & marginal farmers in particular, should be one of generating additional jobs and additional sources of income. The emphasis needed is on use of slack / idle resources, namely, land and labour.

An enterprise is a function of:

- Capital
- Organisational structure and management
- Technology
- Associated risks

Enterprises include both industry and service sectors. Based on the level or degree of the above factors deployed, the nature of enterprise can be one of the following:

(i) Household level enterprise - tiny or cottage industry, for eg. value addition activities like pickle making; or mushroom cultivation using paddy husk; or bee keeping etc. Household level enterprises use very small quantum of capital, low intensity of technology & skill; and organization is simple and is owned & managed directly by the family members. Employs a maximum of 3-4.

(ii) Village level enterprise – village industry or micro-industry, for eg. oil extraction unit, mini dal mill, compost making unit etc. These enterprises are akin to household level enterprises, except for the level or degree of factors deployed being more intense or sophisticated. Since the scale of operation is higher, the entrepreneur is likely to use resources mobilized from a number of farmers and employ non-family member and manage the unit as an enterprise. Generally, the number of people employed is not more than 10.

(iii) Small, medium scale industry - These are professionally managed agro-industries, that encompass both food and non-food sectors. The skilled / educated members of a farm family are likely to be absorbed as employees, benefiting from an additional income from non-farm engagement. However, the farm families can relate with such industries, including the large scale industry by supplying their primary product, as also by-products (eg. paddy husk, cotton stalk, etc.) at cost.

Promoting Household and Village Level Enterprises

The emphasis of the Ministries/Departments of Agriculture and allied sectors at central and state levels should be on promoting largely household level enterprises, that would help to add value to the primary products raised on the farm, and utilizing what is left behind as a waste. This in a way takes for agriculture to the next stage, that can be called as secondary agriculture, leading to capture of additional value for the farmer. With deployment of low intensity capital & technology and skill imparted through appropriately designed training programmes, the members of a farm family will be able to utilize their spare / slack time, particularly during non-seasonal times gainfully.

The Ministry has various schemes to support household enterprises. The institutions like those under ICAR or those under DACFW like MANAGE, NIPHM, etc. can provide incubation and training facilities.

In certain limited cases, the Ministry may be able to promote village level enterprises. For example, mini-dal mills, input retail centres. By and large, village level and higher level industrial enterprises need specialized knowledge, and therefore are best managed by the Ministry of SME.

Organisational Support

Within the Ministry / Department at both central and state levels a specially mandated Division would need to be created to promote secondary agriculture. For example, within the Ministry of Agriculture and Farmers' Welfare at central level, all the 3 Departments, namely, DACFW, DAHDF and DARE/ICAR should set up a dedicated Division for this purpose. Further, there should be a common institutional platform for all these 3 Departments to coordinate their activities. Each of them may also identify various institutions / agencies / organizations under them to serve as nodal centres for field level operations. Similarly, there can be replication of this approach at the state levels.

Some of the initiatives needed at the central level are:

- Identification of suitable enterprises and creating implementable project models.
- Designing modules of orientation and training programmes and kit; and coordinating with the concerned like the Ministry of Skill Development and Entrepreneurship.
- Funding for skill development activities; establishment of incubation centres and related infrastructure.
- Identification of institutions to undertake training and hosting of incubation centres.
- Preparing a bouquet of bankable projects; credit linked back ended subsidy based projects can be promoted.
- Designing of suitable Schemes and Guidelines.

- Creating a window for funding. The restructured RKVY-RAFTAR provides for promoting enterprises under secondary agriculture. Credit available under MVDRA, Banks, NABARD etc can also be availed of.

- Developing standards for adherence to quality and harmonization with different standards to enable easy marketability including online trading.

- Facilitating marketing creation at state, national and international levels, so that the local products find space in both near and far-away markets.

It may be useful to create a Special Purpose Vehicle (SPV) on Public Private Partnership (PPP) platform. Private sector led SPV, wherein professionals with domain knowledge are selected from the industry may be a good option. The Government (dedicated Divisions in the Ministry) may play the role of a facilitator and supervisor.

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7. Beekeeping

Bees have a symbiotic relationship with plants and one of the most important things they do is pollinate plants. Many of the crops raised and foods produced depend on bees and insects for pollination and completion their reproduction cycle. In case of fruit trees, the size and shape of fruit is also affected by bees. Flowers that are visited frequently by bees will tend to produce larger and more evenly shaped fruit. Beekeeping also helps in enhancing productivity of crops, maintaining bio-diversity and environmental sustainability. Human interface in breeding, rearing and managing of bees is an agro-based activity and is easily undertaken to supplement income of farmers. Requiring very little land, this is amenable to small farmers and as a part of Integrated Farming System (IFS).

Honeybees are best known bees, not only for the honey they produce, but also because they play very important role in pollinating various agricultural and horticultural crops and in increasing their yield and improving the quality of produce. Honeybees ensure pollination in cross-pollinated crops as well as provide honey and a variety of beehive products. Pollination is an essential activity, as it enables plant reproduction and pollinators contribute to the maintenance of bio-diversity, and ensure the survival of plant species including crops that form the basis of agriculture and food security. Both, the diversity of wild plants and the variability of food crops depend on this diversity. Any reduction of loss of bees will stress the agri-value system and stress or damage agricultural production.

Impact of Bees on Yield from Farms

It is being increasingly realized that bees could be less expensive input for promoting sustainable and eco-friendly agriculture and enhancing crop productivity. The potential benefits, due to bee pollination, in the form of increase in yields of various crops including fruits & vegetables, oilseeds, pulses and others varies are observed to greatly enhance. Studies reveal that the income generated through enhancement in crop yield is far higher than the income generated from honey production. Honeybees have a vital role in sustaining the biodiversity of the plants resulting in environmental sustainability.

Till the mid-20th century, honeybees were equated with the production of honey and beeswax. But in the past 3-4 decades, utilizing honeybees to pollinate large number of agricultural and horticultural crops to increase their yield per unit of area, time & input, has become the principle objective of beekeeping in many developed countries. In some countries, many commercial beekeepers prefer to provide honeybee colonies on rental for pollination service over relying on income from honey production. According to the Agricultural Scientists, value of additional yield obtained by pollination service rendered by honeybees alone is about 15- 20 times more than the value of all the hive products put together (Dr. Kaloo, 2004, India). In the European Union (EU), studies estimate that pollination services by honeybees adds 35-50 times the value of additional yield obtained.

Beekeeping and Livelihood Benefits

Beekeeping plays an important role in adding to income of rural population, not only by enhancing the crop productivity, but also by outputting a diversified range of high value beehive products, viz.; bees wax, bee pollen, propolis, royal jelly, comb honey, bee venom, etc. The larger impact is maintaining bio-diversity & environmental quality, ensuring food and nutritional security and more.

Productive beekeeping does not require large capital investment, though certain skills are necessary. Beekeeping has potential to generate employment, and estimates indicate that 10,000 bee colonies require about 3,00,000 man-days in a year. As per economics worked out for beekeeping, the net income from 100 bee colonies varies from Rs. 3,00,000/- to Rs. 5,00,000/- annually, which is directly linked with the prevailing market prices of honey & other beehive products and beekeeping equipment.

Honeybees helps in achieving the goal of food and nutritional security and sustaining the environment. As per an estimate, more than a third of the global food basket is comprised of bee pollinated crops. Nectar and pollen collected by honeybees and converted into nutritive & valuable food, viz.; honey and other beehive products, would otherwise go waste. The pollination also helps in maintaining bio-diversity.

Beekeeping requires no land, minimal inputs, is not strenuous and can be adopted by anyone, encourages forest conservation and has potential for value added products, and has medicinal and cultural values. Bee products are used either as food or in pharmaceutical and cosmetic industries. For this reason, hygienic collection, handling, processing, storage, etc. and maintaining National and International purity standards are of prime importance.

Beekeeping status

World scenario of beekeeping:

Millions of honey bee colonies, mostly, Apis mellifera, are maintained all over the world. The world production of honey has been ranging between 15 to 16 lakh tonnes per year. There are 15 countries in the world which account for 90 per cent of the world honey production. In Asia, China is the leading country in production and export of honey, beeswax, bee pollen and royal jelly. China like India has indigenous A.cerana bee colonies but has also introduced A.mellifera bees, an European species.

Beekeeping in India:

The All India Coordinated Research Project (AICRP) on honey bees and pollinators under ICAR and State Agricultural Universities plays a major role in conducting research work for improving livelihood of Indian beekeepers and farmers. The National Bee Board (NBB), under the Ministry of Agriculture & Farmers Welfare, Government of India and Khadi and Village Industries Commission (KVIC) under the Ministry of MSME supported by Khadi and Village Industries Boards (KVIBs) at the state level are the agencies that promote beekeeping in India.

Major Constraints in Beekeeping

The major constraints confronting the development of beekeeping are summarized as under:

(i) Some major concerns are a lack of

- scientific data on choice of Honeybee species for commercial beekeeping and for promoting cross pollination;

- infrastructure for producing genetically superior queen bee for supply to beekeepers;

- technical knowledge for efficient management of bee colonies for higher honey yield;

- infrastructure at grass root level and national level for promoting beekeeping;

- awareness about yield increase in crops by beekeeping through pollination;

- understanding between farmers & beekeepers.

- laboratories for disease prevention, control and analysis. Eco-friendly control measures for serious problems- Parasitic mites (Varroa, Acarapis etc.), fungi (Nosema, Acosphaera), bacteria (Paenibacillus, Melissococcus), Viruses (Sacbrood virus), etc. are required.

- indigenous technologies for production of quality honey & other high value products from beekeeping: Bee pollen, Royal jelly, Propolis, Bees wax, Bee venom, Comb honey, etc. including migration/ transpiration technologies for honeybees.

- institutional support for beekeeping in terms of bank loans, etc;

- proper pricing policy for honey and those engaged in packaging, processing and storing honey;

- consumer awareness of honey and its products; and

- convergence of various developmental programmes.

(ii) Poor quality control for production of honey and quality control labs.

(iii) Beekeeping not on the priority list of states. The State Bee Boards/Missions/ Technical Centres/IBCDs (Integrated Beekeeping Development Centres) and the like need to be established.

(iv) Various hindrances in migration, transportation of honeybee colonies.

(v) Forest Laws/Acts, etc.- charging a fee for allowing bee colonies in forest is a disincentive. The laws are also restrictive of the beekeepers/traders/processors of honey.

(vi) Less emphasis for production of other bee products such as beeswax, pollen, propolis, bee venom and royal jelly.

(vii) The behaviour and life cycle of honeybees depend completely on climatic and floristic conditions, which vary from place to place. Flowering of plants and secretion of nectar and production of pollen – sole food of honeybees, influenced by climatic conditions.

(viii) Insufficient database on beekeeping activities.

(ix) Mono-cropping culture in large parts – not good for bee promotion.

(x) Indiscriminate use of insecticides, pesticides, weedicides etc.

(xi) Lack of coordination between/among bee breeders, entomologist & plant breeders, such as to help to evolve scientific beekeeping practices based on good agriculture and management practices, following both crops and honeybees centred approach.

(xii) Heat-waves and & unforeseen changes in climatic conditions.

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8. Lac Cultivation as an Enterprise

Lac cultivation provides sustained & high economic returns, generates employment opportunities and supports lac based rural cottage industries. Out of 25 crore households in India, about one million farm families are engaged in lac cultivation across the country, especially in the eastern and central parts of India. In major lac growing states namely, Chhattisgarh, Jharkhand, Odisha and West Bengal 25-32 per cent of a family's total farm income comes from cultivation of lac and about one million man-days are generated in the existing lac processing factories alone. Being an export oriented commodity, it contributes towards foreign exchange earning of the country. Globally, India is the leading exporter of lac. Cultivation of lac not only provides livelihood to lac growers, but also helps in conserving the green cover of earth, lac insects and associated biota. India is world leader in production with a production of around 17,000 tons of lac per annum (average of 2010-11 to 2014-15). Lac production is confined presently to Eastern India i.e. Jharkhand (51%), Madhya Pradesh (15%), Chhattisgarh (44%), and Odisha (4%). Though, classified as minor forest produce on certain considerations, lac ranks as a potential source of revenue for farmers. Growing host-trees for timber and fuel yields revenue in cycles of long years, whereas cultivation of lac on these trees gives a return almost every year, and is therefore preferred by lac growers.

Lac cultivation requires plants called lac-hosts. More than 400 plants have been reported as lac-hosts all over the world. Kusum (Schleichera oleosa), Palas (Butea monosperma), Ber (Zizyphus mauritiana) and Ficus spp. account for about 90 per cent of total lac production in the country as host plants. Besides these lac cultivation can be commercially carried on about 30 other host-plants. Recently, Flemingia semialata – a bushy lac-host has been showing the promise for intensive lac cultivation

Role of Lac Cultivation in Disadvantaged Areas of India

There exists 80,000 square km of area under lac cultivation comprising 200-250 millions of host tress across the country, but not all of these trees are utilized for lac cultivation. Employment generation in lac cultivation is about 80-90 million person days per annum, and about one million farm families are supported.

The lac growing regions are characterized by high proportion of tribal population, families living below poverty line and low literacy percentage. The tribal population mainly depends on rainfed agriculture and forest produce for its livelihood, and lac is an important source of cash flow. One of the merits of lac cultivation is that it does not require irrigation or watering when done on tree species. Front Line Demonstration programme executed in various states like Jharkhand, Chattisgarh, West Bengal, Odisha etc. confirm the success of lac farming under rainfed condition.

The NITI Aayog has identified 150 districts as most backward in the country. Many of the promising technologies and research findings have not reached the farmers of these districts mainly due to deficiencies of delivery systems and lack of economic incentives. Among these, lac cultivation is an important vocation for inhabitants of 45 backward districts. Another 30 districts have potential for introducing lac cultivation in their farming system. Jharkhand, Chhattisgarh, Madhya Pradesh, Maharashtra and West Bengal contribute about 95 per cent of the total lac produced in the country. About 200 processing units including button lac, seedlac, shellac, bleached and aleuritc acid units operate in West Bengal, Chhattisgarh and Jharkhand.

Lac Culture as a Profitable Venture

Lac can also be suitably grown on marginal and degraded lands and requires negligible inputs like pesticides, fertilizers and water etc. It gives no competition to other agricultural / horticultural crops. Lac culture acts like an insurance crop particularly during drought years and is a good source of livelihood especially for farmers inhabiting forests and sub-hilly tracts.

The following strategies are employed for sustainable production of lac in the region:

(i) traditional lac cultivation on tree species in forest / sub-forest areas;
(ii) intensive lac cultivation on bushy host plants;
(iii) integration of lac culture with agriculture;
(iv) extension of lac cultivation to potential non lac growing areas; and
(v) training of traditional lac growers in scientific methods of lac cultivation

Lac based rural enterprises

Lac resin is such a versatile product that it makes its presence felt in most of the sectors like varnish, paints, inks, adhesive, food, cosmetics, leather, electrical, pharmaceuticals industry, besides some miscellaneous uses. The wax obtained from lac insect also finds its uses in shoe, automobile and floor polish, bottle sealer, tailor's chalk, crayons, lipsticks and fruit coatings. The scale of operations can vary from a very small-scale cottage unit consisting of 3-5 persons to a very large lac based unit of more than 100 persons. A few small lac based units suitable are as follows:

(i) Lac Processing: The lac produced at farm level is processed in factories for refining. It involves two steps (a) the conversion of stick lac into seed lac (granulated form) and (b) conversion of seedlac into shellac (flake form).

Strategies for Increasing Lac Production and Income

Developmental agencies in different lac growing states have to come forward for promoting adoption of proven technologies of lac cultivation on farmer's field. Similarly, lac industries need to provide feedback regularly and care for farmers cause. The following issues need to be addressed to meet the objective:

i. Speedy decision making on formation of National Lac Development Board to monitor, coordinate, liaise the developmental issues, problems and take policy decisions on: declaring lac as an agricultural commodity, promotion of lac at state level, maintaining buffer stock of lac, price stabilization, implementation of Minimum Support Price, and regularizing export / import of lac. The responsibility of lac development needs be assigned clearly to one of the relevant state departments.

ii. Employment Generation Schemes like MGNREGA need to be linked to lac promotional activities like raising large scale plantations of lac-host trees. Traditional lac host trees i.e. palas, ber and kusum can be planted in waste land, bunds of agricultural field and backyard of farmers' houses and utilized for lac cultivation without costly inputs like fertilizers, pesticides etc.

iii. Credit and insurance to lac growers: Lac is a high value crop with high risk factors. Most of the lac growers being poor and illiterate do not have capacity to procure inputs and their risk bearing capacity is also very low. There is need to have a mechanism to declare large scale crop mortality over larger area as natural calamity, so that farmers could be compensated and supported to sustain their interest in lac cultivation. Subsidized loans from banking institutions should also be available to enterprising farmers for lac cultivation.

iv. Enhancing exploitation of unexploited host plants: Plenty of lac host trees are available in/on farmers' house backyard, agricultural field and forest area. Survey made in Ranchi and West Singhbhum district of Jharkhand shows that host utilization for lac cultivation was very low and it was 28.7 per cent for palas, 53.8 per cent for ber, 17.2 per cent for kusum and 7.4 per cent for other host trees. This indicates a greater scope for increasing lac production by utilizing more of the hosts for lac cultivation. Target atleast 2 per cent increase in lac host utilization every year to reach 50 per cent from the present average of 28 per cent.

v. Revival of lac in traditional production catchments: Some of the districts have potential to cultivate lac. Most of the lac growing districts and the districts which have potential to cultivate lac fall under the category of disadvantaged districts as identified by the Planning Commission/NITI Aayog of India. Efforts need to be made to reintroduce lac cultivation in these districts.

vi. Quality and timeliness of availability of brood lac is the most important in expansion / revival of lac cultivation. The lac growing states should develop brood lac farms in high production catchments (at least one in each district). These could be managed through JFM with technical guidance of IINRG.

vii. Promote ber for kusmi lac as it is highly productive and better in quality. Moreover, it is less prone to large scale mortality that has been witnessed recently in rangeeni strain of lac insect affecting lac production and interest of lac growers.

viii. Flemingia semialata and some other fast growing, short statured and perennial shrubs can be used for lac cultivation on plantation basis in both irrigated and rainfed conditions. These hosts are suitable for lac production during winter / rainy season, with the weekly irrigation also used for production of summer season crop. Lac cultivation can be initiated on these hosts within two years of planting. These are particularly beneficial for those farmers who do not have traditional host-plants but, are interested in starting lac cultivation.

ix. Training in scientific methods of lac cultivation: Survey data collected by IINRG shows that even untrained lac growers earn Rs. 7,200 per family from cultivation of lac and this income was more than double in case of trained lac growers. This demonstrates the scope that exists for increasing income through scientific method of lac cultivation. Income from lac cultivation was found to contribute towards 24.0 and 32.0 per cent of total income and farm income respectively for trained lac growers. Trained lac growers give more emphasis on brood lac production over stick lac production. Higher level of brood lac production resulted in self sufficiency in brood lac and more utilization of host trees for lac cultivation.

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9. Agro-forestry

Status and Scope for Promotion of Agro-forestry

Agriculture and forestry can no longer be treated in isolation and linking these two is imperative for socio-economic development in the twenty-first century (FAO, 2016). Prior to the 'Green Revolution', the majority of subsistence farming anywhere in the world involved growing of mixed species, usually including trees (Mark and Mbow, 2014). Agro-forestry is a land use system, which integrates trees and shrubs on farmlands and rural landscapes to enhance productivity, profitability, diversity and ecosystem sustainability.

Agro-forestry provides both climate change mitigation and adaptation benefits to farmers. In addition to income from sale of agro-forestry products, trees on farms are a critical component of climate-smart agriculture in many systems. Trees regulate moisture, moderating drought or heavy precipitation, and soil temperature. Trees contribute to soil fertility by adding nutrients in the case of nitrogen-fixing species, and they contribute to increasing soil organic matter. Increasing bio-mass carbon on agricultural lands through agro-forestry may also improve biodiversity, water quality, and, in some cases, hydrological cycles (CGIAR, 2017). This is a traditional way of sustainable land management practised in India and its contribution to food, fuel, fodder, fibre and timber is well recognized.

Extent of activities and potential for employment generation

At present agro-forestry meets almost half of the demand of fuel wood, two-third of the small timber, 70-80 per cent wood for plywood, 60 per cent of raw material for paper pulp, and 9-11 per cent of the green fodder requirement of livestock, besides meeting the subsistence needs of households for food, fruit, fibre, medicine, timber etc. (ICAR-CAFRI, 2015). Agro-forestry not only provides environmental services, but also economic gains, as about 65 per cent of the country's timber requirement is met from the trees grown outside forests (SMAF, 2016)

Wood-based products such as paper, pulp and furniture offer vast potential for enhanced income for farmers (NITI, 2017). Employment growth with rising productivity is the most effective mechanism to alleviate poverty to the poor with equity. Dhyani et al. (2003) reported that agro-forestry provides employment with relatively lower investment and that too for the unskilled rural sector. The role of agro-forestry in employment generation through various activities involved in production and processing is well documented. For example, Poplar is a prominent industrial species, which covers less than 2 per cent area under agro-forestry with four to five lakh ha but generates about 90 to 100 million man-days of employment per year. This includes 20 million man-days crop cultivation; 20 million man-days in felling trees and their conversion into logs, grading, loading, unloading, stacking and handling timber; and approximately 50 million man-days in wood based industry involved in converting poplar wood into wood based products in India (Dhiman, 2008 and ICFRE, 2016).

Expected Cost of Cultivation and Financial Viability

There are several studies available on financial analysis of agro-forestry systems in country. Jain and Singh (2000) conducted a study on performance of Poplar-based agro-forestry in terms of income, employment and environmental impact in Shahjahanpur district of western Uttar Pradesh. They reported that Poplar-based agro-forestry is economically viable and more profitable than many of crop rotations followed in the study area. This land use system is also capable for providing employment opportunities Chahal et al. (2012). It recorded highest net income in case of poplar + sugarcane (Rs. 64,355/ha/year), followed by poplar + turmeric (Rs. 59,543/ha/year) and lowest by poplar + rainfed wheat (Rs. 18,719 /ha/year). Poplar alone gave a net income of Rs. 20,188/ha/year. The traditional rice-wheat crop rotation provided Rs. 22,970/ha/year as net income. Deswal et al. (2014) reported that an average farmer earned 46 per cent higher income from poplar-based agro-forestry compared to rice-wheat crop rotation.

There is dearth of valuation of ecosystem services of agro-forestry in country. The estimated value of provisioning services usually found lesser than other ecosystem services such as regulatory, supporting and cultural services generated from agro-forestry. Alam et al. (2014) conducted a study on valuation of ecosystem services of tree-based intercropping in Canada and reported that only one-third value contributed by provisioning services in total economic value of the system. They suggested that farmers only benefitted by provisioning service, hence government incentives are needed to encourage farmers to adopt practices that benefit society as a whole.

The financial analysis of prominent agro-forestry systems prevalent in various agro-climatic zones in India was conducted based on the data from 'Report of the Task Force on Greening India for Livelihood Security and Sustainable Development' of the Planning Commission.

Agro-forestry Support and Interventions Needed

Two new sub-missions under NMSA along with reforms imparted to the relevant Acts/Rules offer a new policy and programme support to promoting agro-forestry. These are:

- National Mission on Agro-forestry
- Restructured National Bamboo Mission

The Government of India's reform initiatives include issue of guidelines entitled "Wood–Based Industries (Establishment and Regulations), 2016" in compliance of the directions contained in the Order dated 5-Oct-2015 of the Supreme Court of India, in respect of rule and regulations for wood-based industries. The proper implementation of these guidelines by state governments would help in correcting the distortions in wood market and will be beneficial to all stakeholders, especially the agro-forestry farmers in the country. Various policy issues related to regulations, which affected the cultivation of trees on private land, harvesting, marketing, transportation, utilization and trading. All these brought out in the National Agroforestry Policy (2014) have been addressed through implementation of Sub-Mission on Agroforestry (SMAF), 2016.

Government of India has been giving a special grant to Punjab, Haryana and western Uttar Pradesh under crop diversification programme (CDP) since 2013-14. The objective has been to diversify rice-wheat system through agro-forestry. Poplar and Eucalypts are among the few tree species promoted under this diversification plan. However, particularly in the state of Punjab, Eucalyptus plantation is encouraged in water-logged areas only.

Agro-forestry model should be specific to size of the farm holdings, soil type and slope of field, capital and labour availability, status of supply chain and market demand of a particular species and over- all marketing infrastructure in a given agro-climatic zone in country. Agro-forestry extension should be equipped with modern technique that can enable to bridge the knowledge gap between research institutions and farmers' fields.

The collection and dissemination of species-wise wood price in various markets also necessary for evidence-based research, forecasting of wood price and economic analysis of agro-forestry systems in country.

Normally, market information for inputs and outputs is not available as in case of other agricultural commodities. Even now market-wise time series data for wood is not available on the AGMARKNET portal, which is necessary for any analysis for market research. In fact, market research is a 'black box' in case of agro-forestry enterprises, because of longer gestation period of tree component.

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10. Bamboo as a Component of Secondary Agriculture

Bamboos are the fastest growing perennial, tall, wide spread and versatile species with ability to produce culms every year. It belongs to the grass family (i.e., Poaceae) and constitutes a single sub-family Bambusoideae. Bamboos have multiple utility (about 1500), that include food, fibre, fuel, construction & engineering materials, panel products, charcoal, medicinal products, paper, flooring, screens etc. Bamboo is also a source of active minerals such as vitamins, amino acids, flavine, phenolic acid, polysaccharide, trace elements, etc. All these traits qualify it to be an asset that fulfils the basic needs of human survival, i.e food, clothing and shelter. Many nutra-ceuticals can be extracted from bamboo culm, shoot and leaf which have anti-oxidation, anti-aging, anti-bacterial and anti-viral properties. It is an alternate form of timber, that is more easily accessible to the poor. Hence, it is a popularly referred to as 'green gold'. In sum, it plays a substantial role in the economy of India and provides livelihood support to millions of people.

Just three countries, namely, China, India and Myanmar account for 80 per cent of the total bamboo area in the world. It is estimated that India is the second largest country in world with 37.8 per cent of the total bamboo forest area after the China (FSI 2011). Bamboo is found in all most all parts of the country except Jammu and Kashmir where it does not occur naturally.

Importance of bamboo

The importance of bamboo comes from its eco-friendliness and large bio-mass production, being a substitute for timber, soil erosion control ability, besides usefulness in maintenance of soil health and amelioration of micro-climate. It is amenable to multiple uses, and is therefore, well suited to value addition activities, generating thereby number of employment opportunities in the rural sector.

Potential of Bamboo in Employment Generation

Bamboo has rural, domestic and industrial uses enabling it to play a vital role in the economy and manpower utilization. The manpower is used in raising bamboo, its maintenance, harvest, transport, storage and end uses. These aspects have been studied and quantified. Every hectare of bamboo plantation generates about 160 workdays. An average of 8-10 workdays is needed to harvest one tonne of bamboo. Five workdays per tonne are generated by transportation and handling of bamboo. As many as 80 workdays are required for processing one tonne of bamboo and its weaving into usable products. In cottage industries, about 600 workdays are required per tonne of bamboo in primary processing

Consortia related to Bamboo

INBAR, Delhi: The International Network on Bamboo and Rattan has its headquarters at Beijing, China with an office at Delhi. It is a premier organization that has networked various institutions, industries, producers and service providers working on Bamboo by bringing all on to a common platform. It is involved in development of technology and extension in all aspects dealing with Bamboo.

NMBA, Delhi: The National Mission on Bamboo Applications with its office at Delhi is a Government India's initiative to give fillip to bamboo based activities in India from all angles including policy development, widening and enhancing production base, value addition, enterprise development, marketing etc. This Mission provides financial and technical support in all these aspects. Now the Restructured National Bamboo Mission has been provided adequate budgetary support (Rs.1290 crore for the year 2018-19).

IWST, Bangalore: The Institute of Wood Sciences and Technology located at Bengaluru is an institute of the Indian Council for Forestry Research and Education (ICFRE) involved in development and dissemination of wood technology. They have developed expertise in preservation and processing of timber including bamboo for enhancing longevity and shelf life of the products and thereby reduce pressure on forests.

NID Ahmedabad: The National Institute of Designs at Ahmedabad, Gujarat is a premier institute in development of designs. This institute has designed high quality bamboo furniture that has export potential. Most of this furniture is based on bamboo poles and is eco-friendly and fully recyclable. This institute has trained a number of craftsmen who can impart training to selected VSS (Village Service Society) members in furniture craft. Training facilities available in this institute are used in training master craftsmen from among VSS members. The growth centre at Asifabad/Kagaznagar can serve as Centre for this activity.

Bamboo as Secondary Agriculture

Since it is a versatile crop and is well suited to less endowed areas, besides being amenable to agro-forestry, the farmers will be able to take advantage of the recently amended provision to the Indian Forest Act, 1927, whereby bamboo stands exempted from felling and transit permit, and incentivising them to grow it on their farms. In sequel, the farm families will be able to adopt bamboo based household level cottage industry for using their inter-seasonal free time more gainfully. They will need training, financial support and market facilitation to do so.

Bamboo is amenable to large number of usages, using which potential small and medium scale industries can be built up, preferably in close proximity to bamboo hinterlands. The farmers can be enabled to tie up with such industries. There also exists scope for educated youth to build aggregation enterprises as gainful employment. Hence, bamboo cultivation holds immense potential to generate household level and village level enterprises.

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Agriculture

Chapter 7

Short Answers

CSM-05: Compiled by Prof. Ashok Vishandass

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This chapter contains:

- Agri-tourism
- Mushroom Cultivation as an Enterprise
- Agricultural Extension
- Changed Role of Agricultural Extension
- Extension System
- Human Resource Use Efficiency
- Information & Communication Technology
- Empowering Women for Income Enhancement
- Strengthening Technology Backstop Institutions
- Research & Development for DFI

Contents

1. Agri-tourism

Agriculture in India is not just an engagement, but determines largely its cultural essence. With increasing aspirations, particularly among the youth, the farmers are well set to transition, beyond traditional farming to generate income via various forms of direct on-farm marketing and farm based non-agriculture business. Tourism is now well recognized as an engine of growth in many countries. The strength of tourism lies in its capacity to generate large scale employment and additional income for the skilled and unskilled. India with its tourism growing at a rate of 8.4 per cent is one among the top 10 tourism destinations of world according to Conde Nast Travellor – a leading European Travel Magazine. In contrast, the world tourism growth rate is just 2.5 per cent.

Agri-tourism is the latest concept in the Indian tourism industry, with agricultural farms as its fulcrum. It leverages the tourists' hunger for an authentic contact with the rural life, local cuisine and familiarity with various farming landscape. The ambience helps tourists to relax and revitalize themselves in a natural way beyond the humdrum of urban life, which has become mechanical and brought in anomy. The target client encompass both domestic (urban inhabitants) and foreigners. In addition to exposing the visitors to the kaleidoscope of the vast and complex agricultural spectrum, the civilizational & cultural efflorescence that include traditional food, handicraft, culture, music, dance and drama that offer them an intense but stress-bursting experience.

Agri-tourism benefits: Generating multiple benefits, of which some are construed below:

- It ensures cash flow during the off season.
- It creates opportunity to sell the experience of agricultural venue.
- It provides opportunity to sell products grown and harvested through agricultural operations.
- It generates employment to a part of rural population.
- It helps in conserving and communicating the values of rural life and agriculture.
- It builds two way communication enabling exchange of information and knowledge between rural and urban inhabitants.

Agri-tourism in India

Agri-tourism has been growing as a niche activity, particularly in the western world over the last century. As a concept, it is therefore not new. In India too, there have been some beginnings, but is yet to blossom as a mature activity. The scope for its growth in India is provided by the following advantages:

i. India's ecological diversity and geographical vastness are its strength. These enable varied and unique experience to the tourists. India's multiple agro-climatic conditions provide scope for more than 3000 crop varieties, apart from varied forms of animal husbandry activities. The geography is a multi-faceted prism with deserts, mountains, valleys, coastal systems and islands.

ii. It has a rich tapestry of people and cultures, each representing uniqueness and highest stage of evolution.

iii. The propensity of the busy-bee professionals and frayed nerves of the city-bred for nonurban tourist spots, is increasingly visible. This can be taken advantage of to build agritourism centres in remote and off-track locations. This will require creation of basic infrastructure, civic amenities and market promotion. The scope for this is now better, thanks to rapidly improving connectively and other infrastructure.

Business of Agri-tourism

Agri-tourism businesses take advantage of the following three basic principles.

i. Have something for visitors to SEE

Animals, birds, farms and nature are few things which could be offered to the tourist. Apart from these, local culture, dress, festivals and rural games could create enough interest among the agri-tourists.

ii. Have something for visitors to DO

Participating in agricultural operations, swimming, bullock cart riding, camel riding, buffalo riding, cooking and participating in the rural games are few activities to quote, for those seeking something alien to their own life system.

iii. Have something for visitors to BUY

Rural crafts, dress materials, farm gate fresh agriculture products, processed foods are the few items which tourist can buy as memento for remembrance.

Furthermore, an increasing awareness in urban citizens of their disconnect with nature, and their desire to connect with more natural lifestyle systems is a key driver. Most of the Indian urban population can still boast of their agrarian background, only a generation or two away and agri-tourism is an opportunity to reconnect with their antecedents.

Recommended Strategies

i) Establish 'Quality Standards' - For agri-tourism in India to be credible, specific efforts are needed in developing a quality standards system. These are standards which should guide general business requirements (i.e. meeting health standards) as well as relate to customer service and products sold. Several of Indian tourism businesses have developed various 'Codes of Conduct', which can be actively promoted.

ii) Encourage use of 'Quality Standards' - The key to ensuring the effectiveness of this initiative is training and awareness of what constitutes a quality product. The apex organization in association with agri-tourism operators should build a consensus around a standard code of conduct and ensure adherence in delivery of agri-tourism products and services. As part of the establishment of quality programs, an industry based assessment program to audit quality of on-site safety and health environment could also be developed.

iii) Develop and promote thematic images of Indian farm experiences - The creation of a world-wide image of Indian agri-tourism experiences will help strengthen growth opportunities and provide new marketing avenues. Such an approach was successful for other tourism sectors including Incredible India, Kerala Tourism, Goa Tourism, etc.; specific to agritourism, the Maharashtra region has been successful in increasing the awareness of its farm touring experiences.

iv) Create marketing materials - To support the image of Indian farm experiences, innovative marketing materials will need to be developed for distribution and awareness generation.

v) There are media avenues that individual farmer and agri-tourism associations can use to reach a wider marketplace. Examples include TOURISM DEPARTMENT website, or toll free number or call centre which can be easily accessed by the public; product guide placed at all visitor information centres; and regional tourism association brochures. Similarly, communication channels can be developed between agri-tourism operators and consumers.

vi) Conflict management programmes - While agri-tourism can create business opportunity for the farmers, it can also generate conflict between primary farming pursuits and leisurely travel activities. This has to be handled sensitively. There can be issues of noise, smell, farming practices, annoyance of behaviour, and disease control. In each of these situations, it is important to establish clear communication strategies on what should be expected on-site with respect to the character of the agri-tourism experience. It calls for developing policies and guidelines for agri-tourism that address effective ways of managing public relations associated with such events.

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2. Mushroom Cultivation as an Enterprise

Mushroom cultivation- an ancillary activity for livelihood security - is emerging as an important agri-business avenue for educated farmers and entrepreneurs. Diversification in farming systems by integrating novel components like mushroom cultivation adds to economic and ecological benefits as mushroom cultivation generates wealth from the waste, and further the agro-wastes get completely recycled as the substrate left after growing mushroom gets utilised as manure.

Further, the areas with rice-wheat cropping system of India are facing several challenges including the tougher one relating the disposal of crop residues. Black carbon emission from bio-mass burning in these regions is one of the important causes of severe air pollution in the National Capital Region. The GOI, through the Ministry of Agriculture, Department of Agriculture Cooperation and Farmers Welfare (DAC&FW), had drawn the National Policy for Management of Crop Residues 2014, which envisaged the adoption of technical measures, including diversified uses of crop residues. It emerges, that declining arable land for agriculture, challenges of handling huge crop residue and changing climate, focus on mushroom entrepreneurship to generate additional jobs and income for the farm families' merits special emphasis. Mushroom entrepreneurship using agriculture residue as raw material requires lesser land area to produce more protein per unit of area compared to many field crops.

Since mushroom cultivation is not capital intensive, farmers with poor financial resources, including those with no land of their own can practise mushroom growing. It is worthwhile to note, that young and aged people are more likely of considering mushroom enterprise as an economic activity. As an enterprise mushroom cultivation is well suited to the educated rural youth. The lean period of agriculture activity in between rice-wheat cropping system offers the farming community a scope to use their labour as well as unutilised crop residue resources to get gainful returns through mushroom cultivation. Income enhancement for the farmers can be achieved by thinking beyond the conventional methods of monetary returns in agriculture. Mushroom cultivation with its potential for monetisable output by using agricultural wastes can become an important avenue for utilization of a farm family's slack time.

Input use efficiency

The profitability of agriculture is influenced by the input costs and input use efficiency. Agriculture is rendered risky and less profitable on account of high cost of inputs. However, in case of mushroom cultivation, the use of agriculture residue which otherwise is not appreciated except as animal feed is used to prepare the substrate/ compost to grow the mushrooms. Hence, unlike in other agriculture and agri-related enterprises, cost of cultivation is less in mushroom cultivation. Mushroom cultivation is least dependent on costly chemicals for plant protection measures. This is an added advantage.

Small scale cultivation of some mushroom species as a seasonal activity does not require much investment. Mushrooms are grown on abundantly available raw materials - agro wastes; to harvest protein rich quality food stuff. The water required to produce one kilo-gram (kg) of mushroom is about 25 litres, possibly the lowest required by any commercial crop.

Post-harvest Management and Processing

Considering that mushrooms have short shelf life, the issues of post-harvest management and options for processing are of paramount significance. For the fresh market, mushrooms benefit from cold-chain to capture maximum value. A value adding activity for the producer, the coldchain for mushrooms requires prior cleaning, packaging and preconditioning the mushrooms for connecting with the consumer through retail outlets. However, most mushrooms still have a comparatively lower marketable life, even when using the cold-chain. However, there are also a number of possibilities of making mushrooms marketable in a processed form.

The processing of mushrooms by preservatives, canning or converting into other food items helps to generate additional revenue. Conventionally, mushrooms are canned and some can be sun-dried. The ICAR-Directorate of Mushroom Research has developed many processed products such as pickle, murabba, samosa, etc. and mushroom fortified products like biscuits and noodles which are becoming popular among the consumers (Shirur and Sharma, 2016). Many entrepreneurs have achieved commercial success in mushroom processing enterprises by their innovative models and recipes of mushrooms. Through this venture, the farmers can realise higher returns over their fresh mushrooms, besides eschewing the losses on account of post-harvest losses that may arise out of inability to market due to short holding life of mushrooms.

Marketing

Many nutritional and functional food products are vying for market and face competition from substitutable products. Simultaneously, monopoly by any single product is also not good. Hence, it is important to diversify the agricultural activities including within horticulture. Mushrooms constitute one such component that not only impart crop diversification but also help in providing nutritious food within a short span of time by utilizing agro-wastes, which are otherwise not used economically. On the other hand, mushroom cultivation strengthens the livelihood of poor and marginal farmers by generating constant farm income and reduces the vulnerability to poverty. Since mushroom cultivation does not require access to land, it is treated as a viable and attractive activity for both rural farmers and peri-urban dwellers.

Cost of Cultivation of different Mushrooms

Mushroom cultivation is a highly skilled and capital-intensive activity under controlled conditions. It involves investment depending on the size of the unit/production targets. However, by introducing tropical and sub topical mushrooms in the production cycle, the yearround mushroom production can be achieved successfully with high monetary returns. In Haryana and Punjab region, mushroom growing is a seasonal activity for marginal and small farmers around cities. These farmers prepare compost either through a long drawn process or purchasing from composting units and sell the fresh mushrooms in nearby market. The temporary structures after cultivation of white button mushroom are lie vacant and remain unproductive. These can be used for cultivation of tropical mushrooms during the warm seasons. Hence, the calculations on cost of cultivation were done on the premise of growing mushrooms in temporary structures (two cropping crops) as per the prevailing climatic conditions. Even in the prevailing circumstances where farmers take just one crop of button mushroom in the huts in the winter months, a farmer earns on an average Rs 50,000 per hut and an acre of land can accommodate 8-10 huts including area for compost preparation. Within four months, the farmer can earn Rs 4-5 lakh per acre, which is much higher than any other crop. The substrate left after growing mushrooms is ploughed back to the fields and it adds to soil health and better production of vegetables and other crops. Chang, 2015 reports, that in China, the economy of villages was totally transformed within few years by adopting better techniques of mushroom cultivation; and that there was 5.5 times increase in the income of farmers between 1991 to 1997 in Biyang region of Henan province, China.

Measures to Promote Mushroom Entrepreneurship

In view of the existing and foreseeable huge opportunities that exist for mushroom enterprise in India, following policy recommendations are suggested.

- Mushroom entrepreneurship must be treated as an agriculture activity for all purposes.

- Two to three KVKs in each state must be identified and strengthened through capacity development and necessary infrastructure to serve as the Centre of Excellence (CoE). It should also be centre for production of spawns.

- Commercial spawn production centres must be incubated, at SAUs, KVKs and public private partnership (PPP) establishments.

- Start-up entrepreneurs must be promoted with right incentives to venture into postharvest technology and value addition in mushroom sector.

- Supply chain management should incentivise the supply of fresh mushroom producers and attract investments in mushroom products through financial support.

• Mushroom as part of the integrated farming system should be encouraged through input supply and subsidies by the development departments.

• Farmer producer associations (FPOs) and cooperative farming must be promoted by bringing the stakeholders associated with mushroom cultivation, marketing and processing.

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3. Agricultural Extension

Agricultural Extension- Empowering Farmers to Help Themselves

India is bestowed with large number of agricultural research institutions spread across the country covering agriculture and allied sectors. As many as 113 Research Centres/Institutes of Indian Council of Agricultural Research (ICAR), 77 State Agricultural Universities (SAUs) – Central Agricultural Universities (CAUs), Water and Land Management Institutes (WALMI), in various states and research institutions of various Commodity Boards, as also their related Ministries/Departments are involved in the generation of transferable technologies encompassing multiple aspects of the agricultural sector along its long chain of pre-production, production and post-production stages including marketing. This research system is supplemented with 700 Krishi Vigyan Kendras (KVKs) located in all the districts of the country for validating & acclimatising the technologies for local conditions.

More than 50,000 dedicated agricultural scientists are working to address field level problems and to evolve technological solutions. However, all the technologies developed by these scientists have not always reached all the farmers. In addition, there are many technologies and practices developed by individuals and corporate bodies in the private sector. Agricultural Extension is, responsible to transfer various technologies and farm management practices developed at research institutions under National Agricultural Research System (NARS) to the fields of the farmers, along their specific value chain, to improve their productivity, production and profitability, besides making this happen on sustainable basis and also negotiating several risks that the agricultural sector is vulnerable to. The research & development outputs become barren, if they do not reach the intended user, namely, the cultivator, the dairy farmer, the fishery farmer, the plantation grower and others engaged in various agricultural and allied activities. Besides playing an important role in transfer of technologies from research institutions to the doorstep of the farmers, agricultural extension also communicates the benefits of developmental programmes of government to the farmers; disseminates information on inputs, credit & insurance facilities, infrastructure, processing, post-harvest technologies and marketing. Such information and education, bring about desirable behavioural changes

Concept behind Agricultural Extension

The term “extension” was first used in the United States of America (USA) and United Kingdom (UK) in the first decade of the 1900s to imply the extension of knowledge from land grant colleges to the farmers, through the process of informal education. In India, extension work was primarily started by F.L. Brayne (1920) in the State of Punjab. The term community development and extension education became more popular with the launching of community development projects in post-independent India in 1952, and with the establishment of the National Extension Service in 1953. Since then, community development has been regarded as a programme for all-round development of the rural people and extension education as the means to achieve this objective. Agriculture, the dominant rural activity has been the core of the Extension Projects.

Agricultural Extension tries to enhance agricultural production by providing the knowledge necessary to make improvements in agricultural practices, and by removing constraints which may hamper the process of increasing farm production (Rivera W.M. 2001). In its role of providing knowledge related inputs for enhancing agricultural production, agricultural extension can be loosely defined as 'a service to "extend" research based knowledge to the rural sector to improve the lives of farmers' (Kapoor, 2010).

As per Anderson, 2008, Extension could aim at bridging technology gap or management gap or both, in the knowledge base of the farmers

- Technology gap bridged by providing better inputs like improved seeds, fertilizers, machinery etc.

- Management gap bridged by providing better farm management practices such as quantity & timing of applying inputs, ways of preparing land for cultivation etc.

- Agricultural Knowledge and Information Systems for Rural Development (developed by FAO and World Bank).

Redefining Agricultural Extension for Doubling Farmers' Income (DFI)

The various definitions brought out in the previous section, as also the prevalent emphasis in India, have largely been production-centric in nature. The approach towards Extension and its focus as well are required to evolve as per the evolving needs of the farmers. Agricultural Extension has, through the decades since Independence, demonstrated its ability to be dynamic and is therefore amenable to its reorientation to meet the current mandate of 'doubling farmers' income'. It is in the light of this contemporary need, that the DFI Committee offers the following definition:

"Agricultural Extension is an empowering system of sharing information, knowledge, technology, skills, risk & farm management practices, across agricultural sub-sectors and along all aspects of the agricultural supply chain, so as to enable the farmers to realise higher net income from their enterprise on a sustainable basis".

The definition brings into focus, the all-important issue of farmers' empowerment through information, knowledge and skilling, in consonances with the popular Chinese proverb, "Don't offer a person with a fish a day, but teach him how to fish." The farmers in India today prefer to be empowered than offered merely a temporary succour. And knowledge empowerment is vital to manage and exercise agriculture as an enterprise that generates targeted profits.

Agriculture Technology Management Agency (ATMA)

Extension services have evolved through the decades, in step with the changing dynamics of India's agriculture. The last major initiative as regards agricultural extension has been National Agricultural Technology Project (NATP), under which Agriculture Technology Management Agency (ATMA) was pilot tested during the period of 1998-2004 in twenty eight (28) districts across seven (7) states. The results in these 28 districts were encouraging and found to significantly drive improvements. These reforms were decentralized decision making; bottom up planning; linking farmers to market; ICT in agriculture; public-private partnership; promotion of farmer's organisations; and gender mainstreaming. Buoyed by this, the Government introduced this concept in 252 districts in Phase I in the year 2005 and subsequently upscaled it to all the then 652 districts. ATMA is a multi-agency platform with emphasis on procedural as well as institutional reforms, leading to effective extension delivery.

Strengthening and reforming ATMA to meet DFI challenges

While ATMA continues to remain a platform of relevance, the outcomes realised have been less than it's potential on account of some dilutions, discussed below:

- Poor participation and commitment on the part of senior officials
- Lack of clear understanding about the principles and practices of ATMA
- Lack of convergence among flagship programmes/schemes under agriculture and allied sectors
- Untimely release of funds from State to ATMA (district unit) and block units
- Diversion of ATMA functionaries into non-core activities
- Capacity building of extension functionaries was not sustained
- Inadequate infrastructure support to extension
- Attrition ridden and unstable contractual manpower; also allied activities like animal husbandry & fishery sector did not receive required manpower
- Absence of effective monitoring mechanism at district level through the mandated ATMA Governing Body (GB)

- Extension services needed to be made more outcome oriented, with a balanced emphasis on both production and post-production activities. This did not happen to levels of satisfaction
- Farm school concept of Farmer-to Farmer extension not fully operationalised
- Poor quality of interaction among members of Farmers Advisory Committee (FAC)
- Lack of integration of agri-preneurs with ATMA activities
- Non-evolution of effective Public Private Partnership (PPP) models
- Quality of Strategic Research Extension Plan (SREP) less than desired
- Poor efforts in promotion and sustenance of farmers groups (FIGs, CIGs, SHGs, FPOs, etc.)
- Ineffective linkages between ATARIs and SAMETIs at the state level and ATMAs and KVKs at the district level and below

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4. Changed Role of Agricultural Extension

Indian Agriculture – Current Context

India is among the fastest growing major economies of the world. Over 58 per cent of the rural households depend on agriculture as their principal means of livelihood. Agriculture as a sector contributed 13.5 per cent to the nation's Gross Value Added (GVA) in 2015-16. Within the sector, the sub-sectors of horticulture, livestock and fisheries have been contributing a larger share of value to agri-GVA since the last decade. Agricultural development continues to remain critical for economic growth, poverty reduction and ensuring food and nutritional security of the country besides meeting other mandates of the agricultural sector.

Green Revolution which brought sufficiency on the food production side, was due to a combination of technologies viz., hybrids and high yielding varieties, fertilizers, improved agronomic practices, assured irrigation and price support policy. This revolution was made possible through an organised and committed effort of Agricultural Extension System (AES). The high production levels achieved is a sufficient evidence of the success of the system that ably supplemented the input intensive production interventions, by transferring modern technologies and farm management practices to the farmers.

However, the interventions mainly benefited irrigated regions and resourceful farmers, bypassing the larger segment of rainfed farming and resource poor farmers. The current phase of agricultural development aims at greater inclusiveness and equitable transformation, whereby all farmers are able to reap economic benefits. The DFI Committee is guided by the fact that more than 85 per cent of the farm holdings are small and marginal, and are economically challenged. To achieve income growth, there is a need for deploying scales of operation, and therefore, the need for promoting new generation farmer collectives, such as Commodity Interest Groups (CIGs), Farmer Producers Organisations (FPOs) and Village Produce Organisations (VPOs) – in the form of Cooperatives, Companies and Societies.

Indian agriculture continues to face challenges, some new and some old, such as:

(i) declining availability/quality of soil, water and other natural resources; (ii) decreasing size of farm holdings; (iii) inefficient use of inputs and their increasing costs; (iv) scarce and more costly agriculture labour; (v) drudgery in farming operations; (vi) growing risks in farming at all its stages from pre-production to production to marketing; (vii) increasing information gap, knowledge gap and skill gap; (viii) poor access to credit and investments; (ix) slow diffusion of relevant technologies; (x) competiveness of quality and prices in domestic & export markets; (xi) inadequate focus on processing and value addition; (xii) inadequate rural infrastructure; (xiii) regional imbalances; (xiv) problems in retaining rural youth in agriculture; (xv) poor access to resources and services for women in agriculture; (xvi) weak institutional/sub-system linkages and convergence; and (xvii) extreme events of climate change on the rise.

Extension Support required by Farmers

Agricultural Extension has to meet changing demands of dynamic agricultural system. Majority of the farmers have successfully shifted from subsistence to commercial agriculture i.e. they now generate surpluses that not only meet family consumption needs, but are available for markets. Thus, farmers increasingly seek market oriented information such as market preference for crop and variety, market demand and prices on real time basis, details on buyers, availability of logistics (aggregation, transport, storage facility, etc.). These constitute business enabling information, which has not been traditionally addressed by public extension. In a way, this has remained a structural weakness which needs to be addressed and reorient and capacitate extension system to take these to the farmers.

The size of the land holdings is gradually reducing which can make the production commercially unviable. The situation demands alternate ways to bring in scale of operation by adopting contract farming and/or establishment of farmer producer organisations, either as companies/cooperatives/societies. Whereas, small land holdings are amenable to operation in a more efficient manner, the movement of produce to markets requires aggregation for logistical efficiency, besides cost effective purchase of inputs. Farmers therefore need details on agri-business companies providing specialised services and possessing interest in contract farming, ways and means of establishment of farmer producer organisations and their linkage with the extension, credit institutions, common infrastructure, processing opportunities etc. This demands new set of information, knowledge and skill on the part of farmers, as also reoriented approach to extension on the part of the extension system.

Migration of people from agriculture into urban areas combined with wage spiralling on account of wage labour under MGNREGA, as also other economic activities in the rural areas, has engendered labour shortage and high labour cost. But, these changes in the rural structure are inevitable and welcome too from the perspective of welfare of rural society. This is also a reflection of the slow growth in economic returns from agricultural activities and its inability to compete.

Water is a scarce commodity which needs to be used judiciously by farmers. Information relating to method of irrigation, quantity and quality of water, time of irrigation, water use efficiency by adopting micro-irrigation systems and sensors, besides crop alignment etc. now need to constitute the new context of advice that the Extension machinery is expected to offer to the farmers.

Negative Impact of Imperfect Information Dissemination

Lack of good and reliable information could result in:

♣ high yield gap; ♣ low seed & varietal replacement rate; ♣ poor crop nutrient management; and ♣ widespread use of spurious/low quality agricultural inputs.

The reduced presence of public sector extension in agricultural extension system beginning with 1990s, the era of economic liberalisation in the country, has adversely impacted the flow of information among farmers. Presently, less than half of the farmers have access to agricultural information, and there exist other aspects like large farmers having access to better sources of information and greater focus of information on fertilizers and insecticides, with lesser attention to other stages of agricultural production. Poor access to information has caused inappropriate adoption of agricultural practices leading to major yield gaps in field crops.

Likewise, in case of pesticides, the problem of spuriousness has been attributed largely to weak law enforcement. While weak enforcement is an issue, spuriousness is as much a result of failure on the part of public & private extension systems. Spuriousness of inputs is a serious problem, because not only does the concerned input (seed, fertilizer etc.) not yield the promised potential, but also adds to the farmer’s cost of production without him accruing any additional yield and income.

Public Private Partnership (PPP) in Extension Services Delivery

Krishi Vigyan Kendra (KVK) has facilities and hires Subject Matter Specialists (SMS) to actively implement mandated activities i.e. technology assessment, refinement and frontline extension. Besides, each KVK is in possession of about 50 acres of land. This provides ample opportunity for Agri-business activities on a Public Private Partnership (PPP) mode, supported by KVK by providing space and technical support, whereas production, processing and marketing are done by Agri-preneurs.

A sharing arrangement between KVK and Agri-preneurs, can be agreed upon. This system will ensure income generating activity in the vicinity of KVK which is a demonstration in itself, augmenting financial resources for KVK, and most importantly, providing additional extension service to farmers for enhancing their income. Activities such as custom hiring, milk chilling unit, nursery, bio-fertilizer, bio-pesticide, honey processing, fish fingerlings production, processing etc., can be taken up in PPP mode. This may be initiated on pilot basis in selected 50 KVKs representing all States including A&N Islands and ATARI Zones and scaled up thereafter to cover all the KVKs.

In fact, the amendments effected to the RKVY Guidelines will be financing agrientrepreneurship and establishment of incubation centres at various research institutions including KVKs. This provision can be made use of in promoting enterprise activities by the KVKs and Agricultural Technology Management Agency (ATMA).

The guiding principle of ATMA provides opportunities for promotion of Public Private Partnership in agricultural extension delivery mechanism. A minimum 10 per cent of the funds of ATMA are already earmarked for public private-partnership (PPP) initiatives. However, in the field, this provision has not been utilised well. There is scope to make this possible, as conceptually it bears merit. Some of the important reasons for poor performance of PPP in the field are:

(a) Absence of credible inventory of private extension service providers in the district (b) Non-operationalisation of GoI guidelines for implementation of PPP models (c) Absence of decision making powers at district level on PPP projects (d) Generic inhibition (mental block) in public system for initiating PPP (e) Non-availability of rigorous monitoring mechanism in place to ensure PPP activities (if any) at district level.

To impart the needed clarity to operationalization of PPP projects, successful models and best practices may be catalogued and popularized. Decentralization of PPP decisions to District level and a progressive National Level Ranking Frame Work (NLRFW) for Extension Service Providers (Public and Private) also need to be put in place. The MANAGE and ICAR Extension Division may work together and publish such NLRFW, through wider consultation.

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5. Extension System

Inputs received by the DFI Committee indicate that at each level - national, state and district, a large number of research and extension institutions working in parallel, tend to target the same set of individual farmers. In doing so, the spread of extension remains limited, with multiple resources duplicating one another's efforts, besides professing variant technologies, resulting in a discordant atmosphere and questionable output. There is need for strong linkages between and among extension sub-systems, and convergence required among the various actors. In this direction, there is need to redefine the management and administrative aspects to promote an inter-linked mechanism in agricultural extension.

Centralised Management of Decentralised Activities

Research System linkage with MANAGE at national level

With large presence of ICAR centres/institutes numbering a high of 113 spread across the country, a wide range of technologies is generated across the multiple sub-sectors of agriculture. It is observed that the ICAR extension units of these Institutes/Centres are by and large confined to a limited geography in their close proximity. While they cannot be expected to own responsibility for all the agri-production regions, diffusion of technology amongst wider farming audience has to be ensured. Ideally, new information and knowledge relevant to a crop or sector, once standardised, should preferably be introduced into the mainstream extension system without delay. It is recommended standardised extension approaches and technologies reach an integrated platform at the national level, from where the same can be disseminated to EEIs and SAMETIs for further diffusion into mainstream extension i.e. state agriculture and line departments. An appropriate platform for this purpose be developed. The same procedure may be adopted in case of commodity boards, namely, Coffee Board, Tea Board, Spices Board, Tobacco Board, Silk Board, Coconut Development Board, etc. and other Central Government Research Institutions.

Converging all standardised practices and technologies on a common extension platform can happen through national level repository of knowledge, proposed as an 'e-National Bank for Agricultural Technologies (e-NBAT)'. Simultaneously, the technologies generated by private sector research organisations and international organisations may also be deposited at "eNBAT". This repository can be managed by a national institute like National Institute of Agricultural Extension Management (MANAGE).

Empowered Directorate of Extension (DOE)

The fast changing role & responsibilities of and expectations from agricultural extension warrant redefining the role of Directorate of Extension (DoE), which is currently a subordinate office of Department of Agriculture, Cooperation and Farmers' Welfare (DAC&FW). It provides technical backstopping to the Extension Division for execution of various extension initiatives. The organisation with its current status does not enjoy the needed autonomy to look beyond the implementation of various extension initiatives.

The changing role of extension from implementation to facilitation, requires conceiving of new ideas that focus on empowering farmers to approach their core activities from a business perspective. This calls for designing and pilot testing of new strategies and models for effective outreach of key initiatives of the department. The DoE can function as a promoter and propagator of innovations in agricultural extension programs executed by both central & state governments, as also private sector & NGOs. It can also undertake concurrent monitoring and evaluation of these programmes. This is possible if DoE is offered greater autonomy and concurrent flexibility in deciding and implementing its activities.

Right technologies for Right people in Right time

MANAGE is mandated to assist state and central governments in strengthening of agricultural extension management. It is to carry out training, research, extension, consultancy, documentation and dissemination of knowledge in the field of agriculture extension management and policy advocacy. It is also responsible for building international bridges and promote two way exchange of extension related knowledge.

The basic responsibility of MANAGE is to assist Government of India in formulating sound extension policies. The assistance is provided based on brainstorming, workshops, research studies, surveys etc. Similar services are also provided to state governments as agriculture is a State subject. It also services private sector organisations as per demand. The Institute also enables proper implementation of programmes by the extension agencies under public (both central & state) and private systems. This support is offered by way of undertaking studies and offering feedback that serves to make necessary corrections.

Linkage amongst MANAGE, EEI and SAMETI

It is important to bring in organic linkage among national level apex body, namely, MANAGE, Regional level EEIs and State level SAMETIs to streamline agricultural extension management. Suggestions made in this regard are as follows:

i. The Director General, MANAGE may be brought in as Co-chair in the Governing Board / Executive Committees of EEIs and SAMETIs.

ii. MANAGE to evolve an institutional mechanism for mentoring activities of EEIs and SAMETIs, especially in identification of training priorities, preparation of training modules, aligning its training calendar and ToT (Training of Trainers) component with capacity building needs of EEIs / SAMETI faculty, training evaluation etc., thereby reorienting the reforms process in the States towards enhancing the farm incomes.

iii. All financial proposals of EEIs and SAMETIs to DAC&FW may receive inputs from MANAGE.

Repositioning the EEIs

Given the need for adopting market led extension, it is time that the Extension Education Institutes (EEIs) move beyond their traditional role of capacity building of extension functionaries in their respective regions. Since, the SAMETIs are increasingly expected to function as extension arms of MANAGE in the States, the EEIs cannot afford to continue with their 'me too' role. In order to differentiate themselves as institutions that can add greater value to the extension services within their jurisdiction, niche set of competencies not currently available in the national extension system should become their new mandate. This would transform the EEIs into Centres of Excellence, each specializing in areas relevant to their locational priorities and agro-climatic conditions.

Research System linkage with SAMETI at state level

The State Agriculture Universities (SAUs) are tasked with a triple agenda comprising academics, research and extension. Their extension outreach programme is defined by validation and popularisation of technologies and farm management practices developed by them within their service areas. Obviously, they are not expected to connect with every farmer, in their service area, which is primarily the mandate of the state extension machinery. However, SAUs can provide technical backstopping and capacity building support to mainstream extension.

State nodal cell (SNC) and its role

The State Nodal Cell (SNC), facilitated by State Nodal Officer, State Coordinator, State Gender Coordinator and supporting staff, should ensure timely receipt of District Agriculture Action Plans (DAAPs) and formulation of State Extension Work Plan (SEWP) with duly incorporated farmers' feedback obtained through State Farmer Advisory (SFA) Committee and further ensure its approval by the State Level Screening Committee (SLSC). The SNC should also focus appropriately on monitoring the implementation of the approved SEWPs by the SAMETI (at state level) and ATMA (at the district level).

ATMA to mantle the extension delivery at district level

ATMA receives e-District Bank for Agricultural Technologies (e-DBAT) from SAMETIs. It is further strengthened by pooling technologies received from private sector research organisations at District level and technologies identified by SREP. e-DBAT provides inventory of all the relevant technologies required for the district after being customized as location-specific technologies in consultation with KVKs.

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6. Human Resource Use Efficiency

Factors in Manpower Requirement in Agricultural Extension

Adequacy of manpower is an important factor in effective delivery of extension services. The manpower requirement has typically been determined on factors such as geographical area, net cultivated area, crops and cropping pattern, number of households/operational holdings and system of cultivation-irrigation or rainfed.

The existing sanctioned strength of extension functionaries, vis-à-vis the positions filled, and relative strength of private extension service providers, determine the total manpower available. The manpower deployed in extension services includes agri-preneurs, DAESI (Diploma in Agricultural Extension Services for Input Dealers) trained input dealers, paratechnicians, NGOs, agri-business companies, Farmer Producer Organisations (FPOs), Cooperatives, etc. Besides, extension is supported through modes such as mass media network, Kisan Call Centre (KCC), network of Krishi Vigyan Kendras (KVK), State Agricultural University (SAU), Central Agriculture Universities (CAUs), credit personnel of various financial institutions, Indian Council of Agricultural Research (ICAR) extension outreach programs etc.

Conventionally, manpower based extension has been the primary vehicle for engagement with the clientele. In an environment where, the level of literacy among the farmers was low and they suffered from long held and strong belief system, that always defied the behaviour change interventions, face to face interface between the extension functionary and the farmer was more credible and effective. Since manpower was always a constraint and other forms of medium had their own advantage in communication, alternatives like traditional art forms and modern forms like print, audio, video and electronic form since the advent of television as a pilot in mid 1970s and more substantively since 1980s came to describe the extension methodology.

Status of Manpower in Public Extension

Indian extension is dominated by public extension. As agriculture is a state subject, majority of the extension functionaries come from agriculture and allied departments of the state. To strengthen ATMA, additional manpower is provided to states by the central government.

As per the information culled out in the year 2012-13, while there were 13.83 crore operational farm holdings, the agricultural extension manpower in position in the country was 1,19,048, which worked out to 1162 operational holdings served by one extension functionary. This ratio applies to the broad agriculture sector and will further vary from one agricultural sub-sector to another, and unfortunately to the disadvantage of emerging domains like animal husbandry.

Assuming that each operational land holding belongs to one farmer/farm family, the ratio is unfavourably much poorer compared to the ratio specified under Training & Visit system of extension. The previously ascertained ratio ranged from 250 to 800 farm families per extension functionary under T&V. In hilly areas, the recommended ratio was one (1) extension functionary per 250 farm families, in irrigated areas it was 400 farm families, and in areas practicing dryland agriculture, it was 800. There are several national institutes under different divisions of the Agriculture Ministry, which are involved in providing various services to farming community, but have limited manpower for extension purpose. Commodity Boards under Ministry of Commerce and Industry i.e. Coffee Board, Tea Board, Spices Board, Rubber Board etc. have their own extension systems which work almost independently; and so is it in case of Central Silk Board under the Ministry of Textiles.

The Department of Animal Husbandry, Dairy and Fisheries (DAHDF) hosts National Fisheries Development Board (NFDB) and National Dairy Development Board (NDDB), under its umbrella which too have their own limited manpower for extension purpose.

All the ICAR centres have their own extension wing with limited extension reach. Further, all the SAUs and CAUs have separate Directorate of Extension, with their own extension manpower to provide extension services in their designated service area. Even though Krishi Vigyan Kendras are meant to provide technology backstopping, they too are involved in extension functions. The Ministry of Food Processing Industries, Department of Rural Development, Ministry of Small and Medium Enterprises (MSME) and Indian Council of Medical Research (ICMR), have their own institutions with limited manpower for extension of technologies generated by them. The Ministry of Science and Technology actively provides value added extension services through ISRO, NRSA and CFTRI. IGNOU has hundreds of programmes meant for different stakeholders in agriculture value system. The Ministry of Finance caters to farmers' credit needs through NABARD, Public Sector Banks, RRBs. Several Inter-Governmental Institutions like FAO, USAID, GIZ, ICRISAT etc. also provide specialized services through their limited manpower. The Ministry of Information and Broadcasting has its own farmers' outreach programmes through Doordarshan, DD Kisan, All India Radio, Community Radios and Directorate of Audio Video Publicity. A listing of public and private extension service providers in India, shows the availability of large number of national level institutions, that provide direct and indirect support to agricultural extension. This is in addition to various state level organisations of similar nature, which also are large in number.

It is important to recognize the following recent developments in the country which have impacted agricultural extension positively. They are:

• Improved literacy rate • Increased reach of mass media • IT and mobile revolution • Deepening internet penetration • Enhanced road connectivity to villages • Increased mobility of extension functionaries • Increase in reciprocal calls and visits of farmers to extension functionaries • Improved awareness bench mark of the farmers • Vigorous outreach mechanism of central and state governments • Aggressive marketing and extension approaches adopted by private extension service providers • Presence of large number of NGOs working in rural areas and serving agriculture and allied activities. • Institutionalised Corporate Social Responsibility (CSR)

In view of the changed scenario, the DFI Committee is of the opinion, that the required minimum ratio of extension service provider to farming family can be revisited. Based on its analysis, the Committee recommends that ratios between Extension functionary to Farm families desired are as follows:

(i) Hilly areas – 1:400 (ii) Irrigated areas – 1:750 (iii) Rainfed areas- 1:1000

Manpower for ATMA

In order to strengthen the state extension manpower, ATMA scheme was modified in 2014 to put in place a committed team of extension functionaries at state, district and block levels. The ATMA Guidelines provide for manpower at different levels as follows:

• District level (Project Director-1; and Dy. Project Directors -2; Supporting Staff (Accountant and Computer Operator)

• Block level (BTM-1 and ATMs-2) for each ATMA.

This works out to a Technical Manpower strength of about 33 for ATMA in a district having on an average 10 Community Development Blocks. As per the total sanctioned strength of each state in line with its eligibility, a total of 27,937 positions were sanctioned across different states. However, as on 15.4.2017, only 13,672 positions were filled, while 14,265 were reported vacant. If these ATMA vacancies are filled up, total number of extension functionaries in the country will go up to 1, 33,313 (ATMA + Regular extension staff) which will improve the ratio of farmers served by each extension functionary from 1162 to 1037. Happily, there exists scope to further improve this ratio, only if all the existing 30 per cent of state extension staff is filled up by all the state and UT governments. In such an event, the ratio will improve from 1037 to 798.

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7. Information & Communication Technology

With the introduction of National e-Governance Plan-Agriculture (NeGPA) during last phase of the 11th plan, twelve clusters of services came to be identified. These includes pesticides, fertilisers & seeds, soil health; information on crops, farm machinery, training and Good Agricultural Practices (GAPs); weather advisories; information on prices, arrivals, procurement points, as also providing interaction platform; electronic certification for exports & import; information on marketing infrastructure; monitoring implementation / evaluation of schemes & program; information on fishery inputs; information on irrigation infrastructure; drought relief and management; livestock management.

Policy Interventions on ICT in Agricultural Extension

The National Policy for Farmers (2007) indicated that the potential of ICT would be harnessed by establishing gyan chaupals (Knowledge Centres) in villages. Further, the Common Service Centres (CSCs) of the Department of Information Technology, Ministry of Communications and Information Technology, Government of India and those set up by the state governments and private initiative programmes will be evolved for inclusive broad-based development. Last mile and last person connectivity would be facilitated with the help of technologies such as broadband internet, community radio or internet-mobile phone synergies (NPF, 2007).

The Document of ICAR Framework for Technology Development and Delivery System in Agriculture (2008) outlined the need for the construction of Agri-India knowledge portal – a single electronic gateway to be developed through a peer review process with the help of 15 content accreditation centres from 15 agro- climatic regions of the country. Each of these accreditation centres can coordinate with other Agricultural Universities and agricultural institutions in their region for development of content in regional language as well as in English. The data may also be validated and may be collected in the central data warehouse integrated in the knowledge portal. The portal may also optimally serve as a platform for facilitation of interaction among researchers and extension personnel in the KVKs through high speed server intranet.

Accordingly, a range of ICT initiatives/schemes aimed at providing information to the farmers on various values adding activities in the agriculture were introduced and are implemented by DAC&FW. These initiatives have been integrated in a manner that farmers are able to get real time information to facilitate their decision making. Such information is intended to be provided to farmers through multiple channels such as through public portals like Farmer Portal, m-Kisan Portal; Kisan Knowledge Management System, Portal on Crop Insurance Scheme, Portal on Soil health Card; and the latest being electronic National

Agriculture Market; Kisan Call Centres, Internet Kiosks, USSD (Unstructured Supplementary Services Data) and SMSs etc.

Major ICT Interventions of DAC&FW

Various ICT interventions have given a new look extension services, both- in terms of improving the outreach as well as the quality of information and knowledge being imparted to farmers. These interventions are discussed below.

(i) Kisan Call Centre Service: Farmers are empowered to seek information by contacting the Kisan Call Centres (KCCs) currently located at 14 stations in different parts of the country through a Toll free no.1800-180-1551. A study report on decision oriented information system for farmers through KCC and Kisan Knowledge Management System (KKMS), m-kisan portal and farmers portal conducted by Centre for Management in Agriculture (CMA), IIM, Ahmedabad in association with AgroEconomic Research Centre, Directorate of Economics & Statistics submitted in August 2017 has revealed that KCC was the most important source of information to the farmers followed by fellow farmers, input dealers, Kisan melas etc. The most sought for areas of information included weather, plant protection, government schemes, market information, fertilizer use/ availability and that on varietal choice. The study also reveals that majority of the farmers expressed that there is a positive impact of KCC information on their production and income levels.

(ii) Crop advisories in the areas of crop management, weather, market price, nutrient management etc. are being sent to more than 1.9 crore registered farmers throughout the nation. It is the KVKs, and District Agriculture Office of the state governments normally send these advisories every week. However, its customization for each district is in pipeline.

(iii) Innovative Technology Dissemination Components like Pico Projectors, Hand-Held devices etc. have been added as an important part of extension reforms process already being implemented through the Scheme 'Support to State Extension Programmes for Extension Reforms'.

Impact of ICT for Agricultural Extension in India

Some impact studies on application of ICTs for agricultural extension have indicated, that the adoption of certain agricultural practices had increased seven-folds with use of ICT over the conventional extension approaches; and Digital Green project showing to be almost ten times more effective per unit of money spent. Further, 85 per cent of adoption of improved technologies achieved through ICT was 85 per cent as against 11 per cent in case of traditional extension methods.

ICTs can effect a paradigm shift in the agriculture sector if brought into the extension system. Such a scope exists in multiple fields including crop production, crop protection, disaster management, market information, market participation, financial institutes and information, natural resource management, fishery, weather information, e-Governance, land administration, livestock management, food security, forestry, sericulture, input management, input availability etc. Alongside this, ICT is also making the farmers more aware and informed about their rights. It is giving voice to their thoughts and is bringing them together, if not always physically but virtually and enable among them a common goal and synergy of efforts.

Suggestions for Promoting ICT in Agricultural Extension

Modern communication technology has proven itself adequately in providing real-time information to farmers on such parameters as weather, market prices, pest and disease status, crop area and production etc. Greater use of ICT systems in extension will make agricultural extension more efficient. Some suggestions in this regards are made as under:

(i) e-Agriculture Policy of national and state governments. It is necessary to adopt appropriate policy, and explore and outline the possibilities of leveraging ICT for efficient agricultural extension services. (ii) Deployment of ICT in extension system will enhance the its out-reach and efficient monitoring. (iii) Human Resource Development: Creating awareness on ICT potentials, ICT using skill and capacity development among the extension personnel of the public and private extension systems, and also among farmers and other stakeholders in the extension systems will facilitate efficient usage of ICTs. Hence, a comprehensive national eLiteracy Campaign may be organized covering all the stakeholders. (iv) Strengthening ICT Infrastructure: Extension organisations and extension personnel need to be equipped with ICTs for facilitating farm information among the agricultural stakeholders. Management information system be used in ATMA & KVKs. (v) Localisation and Customisation of content: Research & educational institutions and extension systems should continuously labour on content localisation and customisation as per the demand of the farmers and other stakeholders. (vi) Integration of ICTs with Public-Private Extension System: Appropriate ICTs to be identified and deployed in the extension system to complement ongoing extension efforts of the public and private extension systems. (vii) Collaboration among Farm Research and Developmental Institutions: Establish strong working collaboration among the ICT initiatives of the research and developmental institutions (IT solution providers). The leading research and educational institutions in agriculture and information technology solution providers should join together to leverage ICT penetration for agricultural extension. (viii) Convergence of Communication Methods & ICTs: For effective agricultural extension service delivery, the convergence of traditional extension communication methods (personal contact methods, print media, radio and TV) and new ICTs need to be blended optimally. (ix) ICTs & ICM: Integrating ICTs and Information and Communication Management (ICM) in agricultural extension will accelerate the pace and intensity of knowledge absorption among various stakeholders including farmers. (x) Social Networks & Open Source Material: Promotion of appropriate use of social networks and open source material to disseminate information among agricultural stakeholders needs emphasis. (xi) Promote Leadership and Find Champions: ICT interventions need leadership. The champions are needed to push projects forward and make them visible and interesting to the agricultural stakeholders. These leaders must operate from local to national level (xii) Provide adequate infrastructure such as, LCD Projector/ Pico Projectors, Tablets, Computers, Internet, Video conferencing facility etc to various extension functionaries operating at different levels.

Areas that are recommended for immediate ICT intervention are as follows:

- Setting up of an Integrated Portal on Agricultural Marketing by integrating websites of: e-NAM, AGMARKNET, APEDA, APMCs, CWC, SWCs, CACP, CCI, DMI, FCI, JCI, KVKs, MPEDA, NAFED, TRIFED, NCDC, NDDB, NHB, SAMBs etc.

- Establishment of AGMARKNET nodes at KVKs and Panchayats using BharatNet connectivity.

- Strengthening of FMC's efforts in disseminating AGMARKNET information through Electronic Display System in Public Places.

- Introduction of technologies for scientific grading of agricultural commodities and electronic records at Village level / Panchayat level.

- Digital access to timely agricultural credits facilities for small and marginal farmers, at reasonable rate of Interest by financial institutions.

- Operationalisation of ICT enabled market-led Extension at farm level.

- ICT enabled Life Long Learning of Farmers (L3F) for their Livelihood.

- Establishment of e-National Bank for Agricultural Technology (e-NBAT) at MANAGE, e-State Bank of Agricultural Technology (e-SBAT) at SAMETIs level and e-District Bank for Agricultural Technology (e-DBAT) at ATMAs level to converge and disseminate appropriate technologies to farmers

- Connecting and facilitating FPOs, SHGs and other farmers' collectives with ICT enabled platforms for e-marketing.

- Enhancing digital competencies of farmers and extension personnel

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8. Empowering Women for Income Enhancement

Rural women form the most productive work force in the economy of a majority of the nations, including India. Agricultural sector is the single largest production endeavour in India contributing 16 per cent of the GVA and is increasingly seeing women come to the forefront. Agriculture including various sub-sectors employs 80 per cent of all economically active women; they comprise 33 per cent of the agricultural labour force and 48 per cent of self employed farmers. About 18 per cent of the farm families in India, according to National Sample Survey Organisation (NSSO) Reports, are headed by women. Beyond the conventional market-oriented narrower definition of 'productive workers', almost all women in rural India can be considered as 'farmers' in some sense, working as agricultural labourers, unpaid workers in the family farm enterprises or combination of the two.

The direct contribution by women across all the sub-sectors of Agriculture is often underreported and inadequately reflected in macro-level data system. Several micro-level studies point to the fact, that women's participation in agriculture in India is anywhere between 60-75 per cent in most of the farm related activities, such as seed preparation for sowing, raising nurseries for seedlings, thinning, sowing, transplanting, weeding, preparation of fertilizers as well as application of fertilizer, in gap filling, winnowing, grading, shifting produce to threshing floor, cleaning and processing the grain etc. Some micro-level studies have even reported, that in selected activities such as cutting, picking, cleaning and drying of grains; and storage and processing, women's participation is almost 100 per cent. Several activities, such as weeding performed primarily by women, are recurrent daily activities lasting from time the seed is planted until it is harvested. This cascades into several hours of work investment by the women folk.

Even in respect of other sub-sectors of agriculture, like animal husbandry, fisheries and vegetable cultivation, women are involved in the core activities including in the marketing of the produce. In the dairy sector, almost 5 million women are active members of the milk cooperatives and as of 2016 there were 32,092 'women only' dairy cooperative societies.

Women Ownership in Agriculture

Despite significant presence of women in agriculture, figures from various data sources present, that their ownership of land in rural households ranges just between 6-11 per cent. Data from the latest Agricultural Census of 2010 indicates, that women's holdings account for 12.79 per cent of all holdings, representing about 10.36 per cent of the total operated area.

Rural women are mainly engaged in agricultural activities in three different ways depending on the socio-economic status of their family and regional factors. They work as:

(i) Cultivators doing labour on their own land. (ii) Managers of certain aspects of agricultural production by way of labour supervision and participation in post-harvest operations. (iii) Paid Labourers on others' farms.

National Sample Survey (NSS) data shows, that there has been steady decline of men in agriculture over the last three decades with their engagement coming down from 81 per cent to 63 per cent as compared to women, in whose case it has come down only marginally from 88 per cent to 79 per cent. This trend can be conveniently termed as "Feminization of Indian Agriculture" As more and more men have moved to non-farm work in the industrial and service sectors, women have remained in agriculture in substantive manner.

Women's contribution on farm and even in home is, however, not computed in monetary terms, thereby by-passing them to a large extent, in planning schemes & programmes, and also in developing strategies to successfully implement them. This paradigm assumes greater significance due to lack of gender dis-aggregated information and data. This is perhaps one of the key reasons for women's limited access to productive resources such as capital and credit; facilities and support services; land & markets; research and technology development etc.

Women in Agriculture - Constraints in their Contribution

Gender Bias: Women suffer from a statistical purdah as a result of which, their contribution is not recognized. They often have heavier workloads than men and bear virtually sole responsibility for family welfare and household management. However, they have either no or at best limited control over productive resources. This is also rooted in gender biases in labour markets and wage rates and has even resulted in their inadequate access to information about rights, opportunities, and support programmes etc. Increasing feminization of agriculture and the agricultural workforce, with little recognition of their role in land and livestock management, has meant that women have largely remained invisible to the government in terms of agricultural policies, schemes, programmes and budgets as well as formal support system such as credit, extension, insurance and marketing services.

Development Bias: Despite the contribution of women in the production process, persistent bias of development planners in treating them primarily as consumers of social services rather than producers, kept them away from the development programmes in agriculture and allied sectors. Some of the new agricultural technologies are reported to have affected farm women adversely. Green revolution had led to the dispossession of small women land-holders, forcing them to join the ranks of wage earners. Wherever the new agricultural technology has led to multiple cropping, the work load of women has increased too. While a number of tasks performed by men have been mechanized, the tasks usually allotted to women continue to be manual and suffer from drudgery. Even where improved techniques have been found for the women's activities, there is not sufficient access to training in such techniques.

Limited Access to Resources: Many of the constraints that rural women are confronted with are similar to those that all resource-poor farmers confront, such as lack of access to land, credit, training, extension and marketing facilities. But, for social and economic reasons, women's constraints are more pronounced and, in general, development interventions that seek to remove constraints for poor farmers do not reach women. Consequently, the development of technologies specifically tailored to women-centric occupations and the involvement of women in technology development and transfer have received inadequate attention from both scientific and administrative departments of governments.

Inadequate access to Markets: Women engaged in agriculture, forestry and fishery tend to produce small quantities and have poor access to organised marketing and cooperatives. Therefore, women sell mainly to private traders and have low bargaining power. Institutions which promote women's group access to market need to be strengthened. Successful examples are of SEWA, Gramin Bank, SHG Federations etc.

Lack of technology refinement for women: Women only benefit from agricultural support programmes if the information, technology and methods imparted are relevant to their production activities. However, agricultural research is generally much less oriented towards adapting technologies to women's physical status or towards addressing their tasks. Women's low productivity stems mainly from lack of appropriate technologies suited to their work.

Inadequate Extension Support: Women farmers also suffer from inadequacy of efforts in terms of content appropriateness and reach. The need for innovative changes in extension programmes for women farmers is felt. The experience of implementing central sector scheme "Women in Agriculture" and various externally aided programmes by the Department of Agriculture, Cooperation & Farmers' Welfare and Mahila Kisan Sashaktikaran Pariyojna of Ministry of Rural Development, has been encouraging as seen from the results and warrants up-scaling of these efforts and strategies. The need for capacity building and skill up-gradation of farm women has now begun receiving the priority it deserves. Special extension and technology dissemination programmes for women are being implemented. However, the span of attention and pace of execution need to be consistently intense, to catch up with the lagging status of women.

Budgetary allocations for Women in Agriculture

DAC&FW has been earmarking allocations to an extent of at least 30 per cent for women under its flagship schemes such as sub-mission on Agricultural Extension (SMAE), National Food Security Mission (NFSM), National Mission on Oil Seed and Oil Palm (NMOOP), National Mission on Sustainable Agriculture (NMSA), Sub-Mission for Seed & Planning

Material (SMSPM), Sub-Mission on Agricultural Mechanisation (SMAM), Mission for Integrated Development of Horticulture (MIDH) and Pradhan Mantri Krishi Sinchai Yojana.

However, evidence from various empirical studies suggests that this is not enough.

- Firstly, the growing presence of women in the agriculture sector over the years, has not been matched with equally substantial increase in the allocations for women farmers. The allocations in some of the beneficiary oriented schemes have been pegged at around 30 per cent without any specific rationale or basis to substantiate the same; these are not in proportion to the number of women involved in the particular sectors. This is only a good beginning and now needs to be refined and allocations made in consonance with the women's share under each scheme.

- Secondly, a look at various schemes of the DAC&FW shows, that as on date out of 55 odd schemes (subsumed now broadly under 7 missions), only around 14 schemes have specifically earmarked allocations for women. Significantly, there are no special schemes under the department that are either meant for women farmers exclusively or those which seek to address the special challenges of women farmers in difficult conditions (e.g., rainfed agriculture) across the country.

Women and Research

Along with an in-depth understanding of women's involvement in agriculture all along its value system, suitability of available technological options for them is an equally important issue. In order to reduce drudgery of work and improve work efficiency of women in agriculture, the technology designing and agronomics have to keep their specific issues in mind. As such, research on gender issues in agriculture and allied sectors including technology refinement in favour of women has to be an ongoing and gender sensitive activity.

The Central Institute for Women in Agriculture (CIWA), Bhubaneshwar is the only centre mandated to push research agenda for women by way of participatory action research in different technology based thematic areas involving rural women. The Centre has been assessing suitability of available technologies for them and suggesting measures to make them women friendly. It also works to catalyse and facilitate R&D institutions to bring in farm women's perspective in their programmes. Besides, an All India Coordinated Research Project (AICRP) on Home Science 12 coordinating centres spread across the country as in operation with a view to developing a strong base for research and extension in State Agricultural Universities for improving the quality of life of rural families. This type of project initiated during the VI Five Year Plan Period, was subsequently merged with the then DRWA (Directorate of Research for Women in Agriculture) in XI Five Year Plan Period. The DRWA is now known as CIWA.

The AICRP on Home Science basically integrates all the five components of Home Science namely, Foods and Nutrition, Clothing and Textiles, Family Resource Management, Human Development & Family Studies and Home Science Extension Education. Each discipline has a specific thrust area of research that has been interwoven to focus on empowerment of women in agriculture. At present, the AICRP on Home Science is being implemented through its 12 Centres located at different State Agricultural Universities of the country, with their focus currently being on –

• Food & Nutrition security in selected farming system • Drudgery assessment and mitigation • Mitigating occupational health hazards • Capacity building of agrarian families • Empowerment of women

However, most of the times such research studies are highly location-specific thereby constraining their applicability across nation. Also, for the research work taken up under AICRP through identified 12 Centres, there is no formal mechanism to share the outcome and recommendations with the development agencies for its popularization among women farmers of different States. It is, therefore, essential to take up need based research activities linked in principle to feedback received from development agencies based on its adoption and performance in the field.

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9. Strengthening Technology Backstop Institutions

Agricultural advisory services are intended to respond meaningfully to farmers, to transfer relevant knowledge and provide advice on diverse demands ranging from on-farm activities to off-farm, finance, business and market related issues. The ideas, advice and information so provided influence the decisions of farmers.

The reality however is that the rural population, especially farm women still have difficulty in accessing crucial information. The challenge is not only to improve the accessibility of information but also to make it available to the fellow women farmers. Modern communication technologies when applied to conditions at grassroots level can help improve communication, participation disseminating of information and sharing of knowledge and skills.

In addition to providing focussed support to farmers through public extension system which is largely man-power intensive, there exists potential to optimise the use of mass media for agricultural extension, which may have to follow the" lab-to–lab; lab-to-land; land-to-land; & land-to-lab modes of network and communication.

Lab-to-Lab & Lab-to-Land Communication

The process of technology generation and refinement is a continuous process. The National Agricultural Research System (NARS) of India is highly expansive and all-encompassing across all the sub-sectors and crop commodities of the sector of agriculture. It may not however be addressing all components of the agril. value system in a secular manner. It now needs to bring due focus on post-production aspects of the system.

There is a need to ensure parallel flow of information related to technology generation and its pooling at one level before the research outcome is translated into an extension message to be shared with farmers. As indicated in Chapter 3, a system has to be developed where research related outcomes flow parallelly and are pooled at the national level to ensure standardised extension approaches. Similarly, regional & state level research institutions viz. ATARIs and SAUs may have to work in tandem to ensure lab-to-lab flow of information and provide requisite extension support through State Department of Agriculture (SDA) & State Agricultural Management and Extension Training Institutes (SAMETIs).

A platform of this nature will also promote multi-directional communication among different laboratories and suggest a concrete partnership on different topics, which may have varying degrees of commonality. This will help in achieving a more comprehensive solution to the field problems, which may be more beneficial to the farmers. It will also bring in optimisation of resource use, namely, men, material and finances, besides saving time. An institutional mechanism for promoting partnership between and among related labs on common farmer related problems would be highly useful, if put in place.

Land-to-Land & Land-to-Lab Communication

Land-to-land system of information dissemination may include individual Contact Methods – e.g. farm and home visits by ESP; Group Contact Methods – e.g. training, demonstration where a group of farmers are educated; and Mass Contact Methods – e.g. television, radio whereby large number of farmers can be reached.

Mass media involves the channels of communication which can expose large numbers of people to the same information at the same time; these are largely used at awareness and interest stages of adoption. These include media which convey information by sound (radio, audio cassettes); moving pictures (television, film, video); and print (posters, newspapers, leaflets).

Land-to-lab refers to conscious effort to identify field concerns and issues and escalate them to the scientists for research in their laboratories. In particular, problem-solving approach will get immediate attention and bring solutions to farmers' field problems. The laboratories will be engaged in real issues and not 'blue sky' research, which may not always be relevant in applied science.

Mass Media in Agricultural Extension

- Spreading awareness of new ideas and creating interest in farming innovations

- Giving timely warnings about possible pest and disease outbreaks, and urgent advice on what action to take

- Multiplying the impact of extension activities - A demonstration will only be attended by a small number of farmers, but the results will reach many more if they are reported in newspapers and on the radio & tele-visions

- Sharing experiences with other individuals and communities - The success of a village in establishing a local tree plantation might stimulate other villages to do the same if it is broadcast/telecast over mass media like radio & TV. Farmers are also often interested in hearing about the challenges/problems of other farmers and how they could overcome them

- Answering questions, and advising on problems common to a large number of farmers

- Reinforcing or repeating information and advice - Information heard at a meeting or passed on by an extension agent can soon be forgotten. It will be remembered more easily if it is reinforced by mass media. Memory gets strengthened through repetition

• Using a variety of sources that are credible to farmers has its advantages too. Instead of hearing advice from the extension agent only, farmers can be brought into contact with successful farmers from other areas, respected political figures and agricultural specialists, when mass media is deployed

Farm Journalism - Vehicle for Extension Services and Outreach

Mass communication and Journalism education assume new significance in the age of globalisation and communication. Mass media are an agent of information education, entertainment and motivation. They open up the farmers to accepting agricultural innovations and technology and therefore serve as a vehicle for such transfer.

Agricultural extension is essentially a communication process, and it conveys improved or recommended or alternate practices to farmers with a view to improving their methods of agricultural production and marketing of their produce.

Professionalising Agricultural Extension through Agri-preneurs

Agri-Clinics and Agri-Business Centre is another public sector mode of providing extension services to farmers, the difference being, that it is on payment basis. These Centres can be utilized to support agricultural extension. These can become effective paid extension service centres run as enterprises by agricultural science graduates.

The selected trainees can be provided agri-preneurship training for a period of two months by MANAGE through identified Nodal Training Institutions in various states, which will also offer handholding support for one year. NABARD can offer the credit support to Agri-Clinics through Scheduled Banks. Such a provision exists and credit-linked back-ended subsidy at 36 per cent has been approved under the scheme. The subsidy is higher at 44 per cent in respect of candidates belonging to SC and ST, as well as women categories and those from Northeastern and Hill states.

Agri Start-ups by Farmers: Stream II of AC&ABC

Considering the vast farmer population of the country and the potential that exists in the process for information dissemination through AC&ABCs and in line with the Government's aim of doubling the farmers' income by 2022, it is suggested to enhance the scope of the AC&ABC.

An additional stream can be created, wherein, farmers with hands-on-experience in agriculture and allied areas but without any formal education in agriculture & allied sciences are also provided training under the AC&ABC scheme, and encouraged to start agri-ventures and join the process of information dissemination. This will provide additional momentum to the creation of self-employment opportunities in the agriculture sector.

Evoking Individual Social Responsibility (ISR)

More than 250,000 agriculture science professionals are working in various public and private research, academic and developmental organisations across the country. Many of these professionals do entertain a desire to contribute to farmers' welfare in the form of individual social responsibility. An appropriate policy support and institutional mechanism can help in channelizing this productivity in a systematic and professional manner and offer farmers an additional service window.

There is need for developing appropriate Operational Guidelines for implementing Individual Social Responsibility (ISR) initiatives for all those working in both public and private institutions. The Guidelines may highlight policy support and incentivise them by offering leave provision, transport allowance and nominal expenses required for implementing individually committed ISR activities.

The ISR activities to begin with may be by free volition of the individuals. Based on learnings from the initial pilots, an element of mandatoriness can be considered. Thus, even small initiatives such as adoption of individual farmer family or a village, large number of professionals will be mentoring the farmers to become more professional and entrepreneurial. These initiatives may be of limited nature, more profitably linked to transfer of knowledge, skills, attitudinal change etc.

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10. Research & Development for Doubling Farmers' Income

From Science of Discovery to Science of Delivery

Science and technology, with the support of pragmatic policies, outcome oriented budgetary allocations and convergence of schemes based on agro-ecologically focused growth engines, will be key to realizing the vision of doubling farmers' incomes (DFI) by 2022. This calls for a change in the mindset on how the research is undertaken – an approach that is holistic, uses modern day knowledge transfer technologies to enable rapid cycle innovation among agri entrepreneurs and farmer organisations, to translate effectively the 'Science of Discovery to the Science of Delivery'.

Indian farmers are presently vulnerable to impacts of climate change, water scarcity and land degradation. In addition, increasing fragmentation of holdings, extreme weather events, rising input costs and post-harvest losses pose an enormous challenge to sustaining agricultural growth. Modernisation of research systems draws strongly on Spatial Data Integration (SDI), especially cloud computing capabilities to integrate data assets across organisations. This will help support modern breeding programs, model priorities and track progress using geo-spatial analytics and apply machine-learning to distil complex data into actionable and relevant recommendations for farmers.

There has been considerable expansion and change in the research and extension system, but the key questions remain: 'Is this sufficient to double farmers' incomes by 2022? Is there a need for a different mindset to ensure that agriculture science empowers farmers to reach their full economic potential? Can this be achieved while delivering nutrition to the nation as well as within the ecological boundaries of India's natural resources?' It is important to note, that 'Demand-Driven Innovation', that leverages participatory research to engage farmers to optimise their individual value chain, and key supply chain actors to design, develop and deliver relevant income centric solutions, takes on a sense of urgency. The core to this modern approach is compressing the time to deliver technology and knowledge at scale and to ensure desired outcomes are achieved.

WHY is a Change in Research Mindset Needed?

Although the Indian agricultural Research & Development (R&D) system has been one of the pioneering systems among developing countries, there are many complexities restricting it from realizing its full potential. Though there has been considerable change in the research and extension system in India, many issues persist. Farming is not generating sufficient income opportunities, with 48 per cent of the population generating only 15 per cent of the nation's Gross value added (GVA). This situation does not support welfare of agriculture dependent population. This requires innovation to reduce production costs and market systems to increase unit prices of farm produce, with both integrating appropriate technology and services to reduce production and market risks. Only if these issues are addressed, will farmers have an opportunity to double their incomes and youth (future farmers) see agriculture as a viable commercial enterprise.

Science of Delivery needs to be Rewarded

Science of Delivery is focused on HOW to realize large and sustained impact that draws on knowledge management and diverse methods of sharing that include large-scale demonstrations to inform decisions, adapt approaches and changed mindsets that accelerate the innovation cycle and ensure local conditions, context and culture are considered in developing and delivering products and services. It also helps compress timelines from discovery to delivery.

The process of understanding how delivery works in agriculture needs to be informed by a broad range of partners across sectors and regions and new tools like social media that aid immensely in this endeavour. Better understanding of delivery challenges and failures will significantly improve system ability to achieve consistent and transformational impacts in farmers' fields and consumers' plates. It needs to be recognized that soft skills are required to work effectively in the domain of delivery, but these are neither taught in agriculture science curricula nor are there incentives within institutions to hone these critical skills.

Compressing Science of Discovery to support Science of Delivery

The first mile (discovery) needs to have the last mile (delivery) in mind. In this regard, the National Agricultural Research System (NARS) should be committed to reducing the time for discovery science to reach farmers' fields. ICRISAT and its partners have adopted this approach in modernization of crop improvement programs to accelerate the development and release of new varieties.

Assessing the status of breeding programs is the entry point for modernization based on best practices used in public and private sector breeding programs. Based on this assessment, prioritised investments were made and implementation of best practices were monitored. New tools included the adoption of a cloud-based breeding management system (BMS), standardized trait ontologies, bar-coding to reduce data error, high throughput genotyping to support marker-assisted breeding, early generation multi-location testing, and crop modelling to target product development and release.

Development of the molecular tools to integrate multiple traits is supported through international and national partner networks that are now utilizing genome sequences to resequence a wide diversity of crop germplasm to develop molecular markers in service of developing diverse, robust and nutritious new varieties.

Another area of rapid innovation is in the integration of modeling, remote sensing, advanced geo-spatial analytics, cloud-computing, internet-of-things and mobile phones. Integration of these tools is providing timely and targeted insights for farmers, agri-business, markets and policy makers. However, the research community is in the early stages realizing the potential of integrating this domain with that of modern crop improvement and farming systems to optimize variety development in the context of farming systems and market demands.

Leverage DFI Agenda to Drive Convergence

The national mandate on Doubling Farmers' Income (DFI) is an opportunity to drive convergence across Ministries (State and Union), schemes, local farmers, supply chain actors, value adding processes, and to accelerate the adoption of sustainable (economically, socially, and environmental) options to empower farmers and produce nutrition to a growing nation. Research and innovation for impact are most important, where, challenges are greatest and the best solutions are delivered by diverse teams – this is true of Indian agriculture. Fortunately, India has been putting in place the digital infrastructure to deliver personalized interventions to farmers through Aadhaar, alongside a wide range of policy support measures to create an enabling environment for farmers and a clear goal to work towards.

In this context, the agenda of research and development needs to be changed to crowd in greater efforts on integrating research and development through active public-private partnerships that are demand-driven and based on sustainable economic growth engines for rural communities. This will require a framework to prioritize research within each agro-ecology and state to frame convergence of schemes, institutions (public and private) and disciplines that include new areas such as nutrition, health and education to deliver on both short- and longer-term development goals of India.

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Agriculture

Chapter 8

Short Answers

CSM-05: Compiled by Prof. Ashok Vishandass

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This chapter contains:

- Genetic Engineering for Crop Improvement
- Role of Digital Technologie
- Digitalisation across the Agri-Value System
- Digitalisation of Villages
- Road Map for Modernising Agriculture
- Structural Reforms for Higher Efficiency
- Structure of Land Holding
- Farmer for Inclusiveness
- Uncontrolled Variables - Production & Market
- Trade Regime and Export Promotion

Contents

1. Genetic Engineering for Crop Improvement

As the world's demand for food continues to increase, plant breeders work to breed high yielding crop varieties. The era of scientific crop improvement dates back to around 1900, when the impact of Gregor Mendel's studies on trait inheritance in peas became widely recognized. Since then, a broad range of techniques have been developed to improve crop yields, quality, and resistance to disease, insects, and environmental stresses of different nature. Most of the plant breeding programs rely on manual cross-pollination between genetically distinct plants to create new combinations of genes.

Genetic improvement of crop plants through conventional plant breeding has made impressive contributions to the breakthrough in the global agricultural production. India too has benefitted from the progress in science and technology. It has provided the platform for the Green Revolution, and laid the foundation for social and economic gains over the last 50 years. The nation has, however, hardly used 1-5 per cent of genetic resources available in the country so far. India has rich genetic diversity pool of its own. At the global level too, there still exists vast scope of genetic pool that can be tapped for achieving crop and livestock improvement. Increases in global food production have kept pace with increase in population from 1960 to 2015. In this period, world cereal production doubled and per capita food production increased by 37 per cent. Most of the productivity gains have been due to yield increases, particularly those resulting from the discovery and deployment of dwarfing and other useful genes in wheat and paddy, apart from maize. The progeny plants are intensively evaluated over several generations and the best ones selected for potential release as new varieties. The more advanced techniques involved in breeding new and improved crop varieties include mutagenesis, genetic modification, and marker aided selection (MAS). Genetic modification allows plant breeders to produce a crop variety that could not have been bred using conventional breeding techniques, and is much more precise, in that, it transfers only the desired gene or genes to the recipient plant. It is a technique, that has broken inter-species barriers, opening up a new world of possibilities and be able to surmount the challenges.

Genetically Modified (GM) Crops – Role and Potential

An array of tools and techniques in the field of molecular biology has become available over the last about 35 years for supplementing the conventional genetic approaches. Advances in modern biology, especially bio-technology, offer many advantages over traditional techniques of plant breeding. Genetic transformation and genome editing are powerful methods that can offer solutions to several problems. The most compelling case for bio-technology, and more specifically transgenic crops, is their capability to contribute to: i) increasing crop productivity, thereby offering support to build global food, feed and fibre security; ii) lowering of production costs; iii) conserving of bio-diversity, as a land-saving technology capable of higher productivity; iv) more efficient use of external inputs, for a more sustainable agriculture and environment; v) increasing stability of production to lessen suffering during droughts/famines arising from abiotic and biotic stresses; and vi) to the improvement of economic and social well-being of the poor.

The term 'genetically modified' (GM) refers to insertion, integration and expression of desired genes of another species or genera in an organism using a series of laboratory techniques collectively called recombinant DNA technology. Other terms used for GM plants or foods derived from them are genetically modified organism (GMO), genetically engineered (GE), bio-engineered, and transgenics, etc. The area of plant bio-technology can be divided into four broad subjects as follows:

i. Plant genetic engineering (gene isolation and transgenic crops) ii. Molecular breeding (marker aided selection) iii. Genomics (genomics, metabolomics and bio-informatics) iv. Genome editing.

Genetically Modified Crops - Global Picture

In a number of countries, transgenic crops are by now produced in more or less a routine manner in both monocotyledons (monocots) and dicotyledons (dicots). Dramatic progress in transformation techniques has widened the genetic base across the species barrier. As per ISAAA, 2017 the global canvas of genetically engineered agricultural crops has seen a vast expansion since its first adoption in 1996 to a record 2.1 billion hectares in 26 countries in 2016. An array of agriculturally important traits has been targeted for modification. The advantages of transgenic technology in improving the major traits are of relevance to Indian agriculture in the current circumstances, characterised by higher aspirations among the farmers and the new challenges, particularly relating to climate change.

Genetically Modified Crops – Status in India

In India, the G.M. technology has been adopted for long. The technologies under use in India have been those developed outside and introduced into the country, as also those developed locally.

In India, cotton is the single most important crop, that has adopted GM variety. Globally, the cotton market is heavily dominated by India and China with regard to both production and consumption. The two countries produced and consumed over 55 per cent of the total cottonseed oil made during the year 2015-16. This dominance is largely attributed to the large amount of cotton cultivation in the region and the high domestic demand for low-priced cooking oil. Thus, in the last fifteen years over 2002 to 2016, cottonseed has become an important source of oilseed in India. This is borne out by the three-fold increase in production of Bt cotton-based oil from 0.46 million tons in 2002-03 to 1.50 million tons in 2016-17. Remarkably, Bt cottonseed oil accounts for as much as 15 per cent of the total production of ~8 million tons of edible oil from all domestic sources, in the year 2016-17.

In the year 2016-17, as many as 7.2 million number of cotton farmers adopted Insect Resistant (IR) cotton [Bascillus thuringensis (Bt) cotton] representing 96 per cent of the estimated 11.2 million hectares of cotton area in India. In recent years, farmers have increased the density of cotton planting particularly in irrigated and semi-irrigated conditions, leading to substantial jump in cotton productivity per hectare across the states. The major states growing IR resistant Bt. cotton in 2016 include Maharashtra, Gujarat, Andhra Pradesh and Telangana, Madhya Pradesh, Punjab, Haryana, Rajasthan, Karnataka, Tamil Nadu and Odisha. The high adoption percentage of IR cotton by farmers across different states reflects the importance of controlling the menace of the American bollworm complex, a group of deadly borer insects that were causing heavy damage to cotton crop in the past.

Transgenic Crops and their Adoption in India

The quantum jump in agricultural productivity achieved by the country during its 'green revolution' phase of the 1960s & 1970s has over the last decade been showing signs of fatigue. The yields have plateaued. The journey of crop improvement that began with the domestication of a desirable plant type present within the nature has entered the era of crop bio-technology, wherein, a crop genotype can be tailor-made into a 'designer crop'.

The techniques of new biology or molecular biology have unravelled the genetic basis of yield components; identified genes across the organisms which can impart tolerance against biotic and abiotic stresses; modified nutritional status of the harvest; and even added industrial or pharmaceutical value to the crops to make it a commercial raw material. It has also provided means and ways to transfer the genes into the desirable compartment of the cell and in turn the plant type per se.

The technological developments in understanding the various processes of biology which in the context of crop improvement define the basis of various agronomically desirable traits were particularly hastened, once the techniques of plant transformations, i.e., ability to introduce genes across the barriers of species were discovered. This has paved way for finding solution to the long-standing breeding objectives which were otherwise difficult to accomplish through conventional breeding techniques. The technique of plant transformation since its first demonstration in 1983 by three research groups has been improved phenomenally and now transformation protocols are available for almost all the major crops (Gelvin, 2017).

Adoption of Transgenic Technology in Non-food crops

India has established a comprehensive regulatory system to deal with application GM technology in agriculture as discussed above. Commercialisation of GM based crop release is system based and passes through rigorous protocol. Notwithstanding the rigour of protocol, the doubts around the food crops based on GM technology continue to occupy the minds at various levels.

There has also been widespread resistance from the society at large, particularly in respect of food crops, and hence the progress relating to commercialisation of GM crops has not been proportionate to the potential and promise that GM technology holds. Under the existing regulatory system, so far, five events of cotton with genes MON 531 (cry1AC gene); MON 15985 (cry1AC & cry2Ab); GFM Cry1A (cry1Ab-cry1Ac); JK-1 (cry1Ac) and CICR (cry1Ac) have been approved for commercial use. Further, at least 4 new events of cotton and one event of brinjal EEI and corn each, besides mustard have been under consideration by GEAC.

In case of food crops, use of genome editing which does not suffer from the safety fears associated with other transgenic technologies can be considered. Further, the conventional breeding technology can be continued to be relied upon by using the vastly unused gene pool available in the genetic diversity of the country, as also from imports. There are well established germplasm banks across the world today and can be accessed.

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2. Role of Digital Technologies

In many developed countries, farming has been modernised by a wave of technologies, adopted at farm level. In emerging economies too, agriculture is becoming “Industrialised”, and spoken of as a “Value System”. Digital technologies are finding increasing use in the agricultural value system, and farmers are increasingly becoming more informed, as various measures are taken to provide them ready access to technology and information. High-tech farming is becoming the standard, thanks to use of sensors, logic controlled systems, data analytics, etc. In India, the increasing availability of energy and internet connectivity to the large rural landscape is further accelerating such changes. This transformation will continue as linkages with international markets also get expanded and get more robust.

The transformation comes from the stark changes that technologies bring about on age old practices and from informational inputs that effect a rethink in the decision making processes. The transformation also causes disruptions as it builds aspirations and competition, which in turn can amplify various errors and omissions. Various examples of changes that technology can bring in the operational environment abound. Some are simple and already a part of history.

When communication systems were analog in nature, the market yards were literally assembly points for farmers to collect and exchange information. The market network was also used by the government as a platform to propagate information and ideas, and to regulate. With the advent of digital communication, the information dissemination progressed onto radio, television, and is now using mobile and internet technologies. The physical assembly of people is not needed and markets should no longer be considered assembly points but as modern platforms where produce can be aggregated in a scientific manner and as initiators of trade that is transparent and offers a choice of markets to the producers. Digitised information systems allow remote access to knowledge, has given rise to group sharing and continue even now to revamp how societal exchanges happen interpersonally, commercially and in the extension services system.

Applying Remote Sensing in Agriculture

One of the pre-requisites for enhanced and stable farm incomes is sustainable and efficient management of agriculture yield and output. Management of diverse crop growth ambience, uncertainties of climate, soil and water regime will require pertinent and timely crop and soil information on temporal and spatial basis. Thus, a farmer needs to be informed well in advance of the probable upcoming problems and outbreaks. The relevant technologies for generating the required information at requisite spatial and temporal scales comprise remote sensing with satellites, drones and localised sensors, and mobile-based Information Technology (IT) applications. The possible components for modern management of agriculture are:

• Remote sensing • Geographical Information System • Data Analytics • Artificial intelligence & Machine learning • Internet of things

Remote sensing fundamentally made use of visible, near infrared and short-wave infrared sensors to form images of the earth's surface by detecting the solar radiation reflected from targets on the ground. As technology developed further, and resolutions improved, remote sensing has advanced to also detect and identify heat signatures of planted crops and animals. Similarly, moving beyond sonar, ocean temperature maps are used to show upwelling and chlorophyll distribution to identify coastal productive zones, use side-looking airborne radar to detect shoals of surface swimming fish, etc.

ICT based support for Farmers

The Ministry of Agriculture & Farmers' Welfare targets improved awareness and knowledge efficiency of farmers. A comprehensive ICT strategy has, therefore, been developed not only to reach out to farmers in an easy and better way, but also for planning and monitoring of schemes so that policy decisions can be taken at a faster pace and farmers can be benefited quickly. To empower different sections of rural areas, different ICT strategies have been devised and are listed below:

• Those who have access to digital infrastructure can get the information through websites/web portals.

• Those who have smart phones can access the same information through mobile apps.

• Those who have basic phones, can get this information through SMS advisories sent by experts.

• Farmers can also call at the toll free number of Kisan Call Centre – 18001801551.

Agriculture 2.0 (Digital Agriculture)

Under Digital India interventions, the Government has given prominence to ensuring availability of information on various agriculture and allied sectors activities, to improve the agricultural output. Agriculture 2.0 (Digital Agriculture) directly falls under Pillar No. 5 of Digital India, i.e. eKranti – Electronic Delivery of Services and broadly caters to other pillars as well, like e -Governance: Reforming Government through Technology, Information for All and Early Harvest Programmes. (It is worth noting, that, Digital India is architected on 9 pillars in total). Some of the key thrust areas identified under Digital India for Ministry of Agriculture & Farmers' Welfare are incorporation of space technologies, development of mobile apps, GIS Mapping, citizen-centric services for Cooperation, fertilizer testing labs, cold-chain availability, identification & development of services for specific sectors of horticulture and fisheries, use of crowd sourcing, increasing online transactions, and use of innovative technologies like text to speech, image recognition; as also Big Data Analysis and Data Intelligence, Direct Benefit Transfer etc.

Upcoming Technologies

Developing technologies such as Big Data Analytics, Internet of Things (IoT), Block Chain, Artificial Intelligence, Robotics & Sensors, etc. are inter-related and are used to optimise the decision making process, and the operating procedures of every sphere where they find application. These technologies are practices that are deeply inter-woven with computerised systems, complex digitised interactions and even self-learning models. In contrast, agriculture involves earthy processes such as attending to soil & water management and cultivation, managing the production and supply of goods. However, agriculture, despite being civilization's primary organised production process, continues to be subject to uncertainties across various involved disciplines. Not only has agriculture moved beyond sustenance farming into commercial production, it now touches more lives than the population immediate and local to the producing region. Its circumference of influence is only bound to widen as rural population moves into urban agglomerations, and nations gets globally integrated.

Agriculture no longer drives other economic and social activities, as in the past, but is subject to and is expected to reflect the demand from the wider population. Though the agricultural system, directly impacts on quality of life of all individuals, evens those in non-agricultural activities, it in turn, is expected to be led by the demands from its end-consumers. A physically inter-connected world has made agriculture a highly competitive production and marketing system. Nevertheless, agriculture still has a certain fuzzy logic built into its operations, as the factors that affect the system, have various degrees in how they manifest. The widening scope of agricultural activities, its continued subjectivity to uncontrollable environs, the large quantity of data it generates from dispersed locations, and the increasing need to have focused & specific deployment of agricultural sciences has made the agricultural system an important domain for use of aforesaid new technologies.

Digitalised technologies in Farming

All current and upcoming technologies hold the potential of catalysing innovations in organisation that would leads to improvement of agricultural models. By adopting Data Science and an analytical approach, various solutions can be found to erstwhile insurmountable challenges, to minimise risk and maximise profit of the farmers. Smart systems have been brought into use in India's Dairy Sector by private sector organisations, for improving agrisupply chain parameters, including milk production, milk procurement, cold-chain, animal insurance and farmer payments. The introduction of smart technology into farming practices provides a new way for farmers to manage natural resources and hence, the economic profitability of the farm. Smart Farming uses modern automation and IT (Information Technology) to increase the productivity and efficiency of modern farming in a sustainable way with minimal impact on the environment. The current array of technologies would include the integrating of Internet of Things (IoTs), Satellite Monitoring, Mobile devices, Soil / Plant Sensors, Smart Zone Seeding, Autonomous Robotics, Weather Modelling, Fertilizer Modelling, and Smart Micro-Irrigation. The systems would require to be standardised and inter-compatibility ensured, so as to be most relevant.

Business models are changing and are trying to develop software platforms that will act as farm-management systems, which will collect data from individual farms and process them, allowing for the farm's history, the known behaviour of individual crop strains and the local weather forecast, and then make recommendations to the farmer. Information, when combined with geo-mapped land, creates a yield map that shows which bits of land are more or less productive, and thus in turn be fed into the following season's planting pattern. Farming solutions are facilitated by using technologies such as, Big Data (e.g. Agriculture Statistical System - Scientific Disease Monitoring and solutions), for subsequent analysis and use in Artificial Intelligence applications. The solutions they lead to can be such as, remotely controlled irrigation water management, site-specific farming (variable rate) for adaptation of the cultivation to the heterogeneity within the field (soil testing, landscape, microclimate), maximise yield potential and improve crop quality, reduce amount of inputs and environmental impact, etc. The technology and applications are suggestive of the scope and scale possible. The impact on analytics in rationalising priorities and expediting the policy making process is yet to be fully realised.

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3. Digitalisation across the Agri-Value System

Strategic Use of Technologies in the Agricultural Life Cycle

The use of a hi-tech machine or a computer aided technology can make a particular farmer more efficient in operations and decision making, and actually up the value added by the farmer by his cultivation activities. Similarly, the use of warehouse management and inventory management software will augment the value added by that individual warehouse. The use of digital way bill and GPS vehicle tracking, electronic warehousing receipts, sensor controlled irrigation, digitised finance, use of ICT in extension services, etc. are other bits of examples that can make an individual enterprise more competitive in their sphere of operations.

The use of multiple quality or market standards, makes the market system ineffectual and non-transparent. In governance matters, non-standard data disallows development of harmonised dashboards for monitoring and decision making. Lack of harmonisation in knowledge management and dissemination also adds to confusion and conflicting conclusions. The standardisation and digitalisation in the chain of agricultural and linked activities will support focused and targeted implementation, a greater convergence in efforts, improved monitoring of implementation and equitable development of this primary sector.

Existing Status and Concerns

Various digital technologies are being developed for use in agriculture, both by the public and private sector. The public sector plays the major role in the satellite and observatory based weather forecasting system, geo-spatial crop forecasting and insurance monitoring system, and digitalisation of land records, market price monitoring and other large scale, high cost functions, which have a wider socio-economic impact across areas. The public sector also has many institutions and agencies that develop and implement solutions that are specific to crops, regions or a set of activities, for subsequent sharing of the solution. The public service envisioned is implemented at a low or zero cost to end-user, or through passing on the technology to partnering private sector agencies.

The private sector predominantly focuses in developing solutions and products that target problems, that are more specific to a prospective range of end-users. The data used by private sector solutions can be independently gathered, or sourced from data generated by government services. For example, the data provided by government on crop production, yield, weather, market prices, etc., is freely used by the private sector for analytics and developing solutions.

Major ICT interventions of Agriculture Ministry

The three departments under the Union Ministry of Agriculture and Farmers' Welfare have developed several ICT based technologies. These have also evolved over the years into robust windows. Some of these are discussed below:

Websites/Portals:

In order to meet the information needs of the farmer, Ministry of Agriculture and Farmers' Welfare has developed different websites and web portals that allow farmers to access the information using Internet. Information on Market Price, Soil Health Card, Crop Insurance, Government schemes etc. is available to farmers through these websites. These websites also aim at enhancing communication between the research institutions and the farmers. They have also helped improve communication and knowledge sharing between researchers and subject-matter experts. Farmers' Portal, Agmarknet, Soil Health Card Portal, eNam, Crop Insurance etc. are some of the examples of web portals developed for farmers.

Use of Mobile Apps:

Diffusing agricultural related information to farmers spread across the vast geography is made easier by proliferation of mobile phones. Today, mobile apps and services are being designed and released in different parts of the world. Mobile apps help to fulfil the larger objective of farmers' empowerment and facilitate in extension services which can address global food security, agriculture growth and farmers' welfare.

Use of basic mobile telephony:

Mobile telephony has transformed the tenor of peoples' lives. In India, increased penetration of mobile handsets, large number of potential users, increased spread of communication, and low cost of usage are leading to growth of large number of mobile based information delivery models for the agricultural sector. A few of the modes used to meet the information needs of the farmer are SMS, IVRS, OBD, USSD etc. In mkisan (mkisan.gov.in), around 2 crore (20 million) farmers are registered (2016-17) and experts/scientists of different departments like Indian Metrological Department (IMD), Indian Council of Agricultural Research (ICAR), State Government, State Agriculture Universities send information to farmers.

Personalized Information through Call Centres:

Kisan Call Centres (KCCs) were launched by the Ministry of Agriculture and Farmers' Welfare in 2004 to bridge the gap between farmers and the technology assessment. This initiative was aimed at answering farmer's queries on a telephone call in their own language / dialect.

At present, the KCC services are managed from fourteen locations. All KCC locations are accessible by dialling a single nation-wide toll free number 1800-180-1551 through landline as well as mobile numbers of all telecom networks from 6.00 A.M to 10.00 P.M. on all 7 days a week including holidays. KCC enables farmers to engage in direct discussions with the subject matter experts who are able to analyse the problem effectively and provide the solution directly. For every KCC location, Level-II experts are also identified from State Agriculture Universities, KVKs etc. In case, Farm Tele Advisor (FTA) is unable to provide answer to the query of farmer, call is transferred to Level II expert. Around 25,000 calls are received daily in KCC.s

Use of Technology for Data Collection & Monitoring:

Use of mobile apps to collect data from the field is indeed a revolutionary change. It can definitely avoids human error and increase productivity.

CCE Agri is a mobile app used for data collection and data monitoring in rural areas. Data of crop cutting experiments (CCEs) is digitized using this mobile app which definitely removes chances of human error and reduces the time in data collation. This app significantly improves data speed (from harvesting to insurance loss estimation) and biggest gain is data quality. Geotagging ensures field visit, photos mitigate the manipulation risk and data transfer greatly improves data consolidation/analysis which eventually results in quick claim settlement. In rural areas, there are challenges on account of absence of or poor connectivity. Hence, this (CCE Agri) app has been designed in such a way, that data can be collected without internet connection and as and when internet is available, data can be pushed to the server.

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4. Digitalisation of Villages

Sustainable Development of Village – Ongoing Efforts

The demand of rural India today is sustainable growth and development. Expanded reach of the Government – both spatial and demographic – is the corner stone of e-Governance. In 1990s, when digital technologies for village level development were rolled out, it only had database technology and computer technology that merely facilitated management information system (MIS) reports.

India needs an economic movement that starts in villages, and not one that tends to bypass them. There had been many efforts to establish “Village level Database” for micro level planning and decision support, and “Village level Knowledge Management System” for checking farmers’ distress (e.g. Information Village Project of IDRC/MSSRF Chennai, Village Resources Centre of ISRO, Village Knowledge Centre of CAPART, Village Knowledge Centre of Union Bank of India etc).

Village Knowledge Centres (VKCs) were envisaged as information dissemination centres providing the farmers instant access to latest information/ knowledge available in the field of agriculture, starting from crop production to marketing. “Mission 2007: every village a knowledge centre”, was proposed in August 2007, so as to facilitate convergence and synergy among the numerous on-going as well as emerging programmes. While the green revolution technology has helped improve the productivity and production of rice, wheat, and few other crops, the knowledge revolution would help to enhance human productivity and entrepreneurship.

The National Alliance for Mission 2007 Initiative had received support from the United Nations Development Programme (UNDP), the International Development Research Centre (IDRC) and the Canadian International Development Agency (CIDA), the Swiss Agency for Development and Cooperation (SDC), the United Kingdom's Department for International Development, the World Bank, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the World Health Organisation (WHO), the Food and Agriculture Organisation (FAO), the World Food Programme (WFP), the International Fund for Agricultural Development (IFAD), the McArthur Foundation, the Jhai Foundation, and the Global Knowledge Partnership.

This National Alliance, then, included 22 government organisations including the Ministry of Information Technology, the Ministry of Panchayati Raj, the Telecom Regulatory Authority of India (TRAI), and Bharat Sanchar Nigam Limited (BSNL); 94 civil society organisations; and 34 private sector information and communication technology (ICT) leaders such as

NASSCOM, TCS, HCL, and Microsoft. Besides, 18 academic institutions such as the Indian Institutes of Technology, and the Indira Gandhi National Open University; and 10 financial institutions such as the National Bank for Agriculture and Rural Development (NABARD) and the State Bank of India (SBI).

Last Mile Connectivity

Last-Mile technology represents a major challenge due to high cost of providing high-speed and high-bandwidth services to individual subscribers in remote areas. Laying of wire and fibre optic cables is an expensive undertaking that can be environmentally demanding and requires high maintenance. Broadband wireless / wired networks viz., BharatNet, Cable TV Networks, RailTel, Electricity Lines, LoRaWAN, TV White Space Technology etc., will eventually be required to provide the solution to achieve "last mile connectivity" of Digital India Programme.

The on-going Digital Network for Farmers (DNF) over the Broadband Wireless/ Wired Network with APP such as KRISHAK MITHRA Software (KMS) will establish the "last mile connectivity" to have farmers "digitally included" for ushering in "Digital Agriculture India" effectively.

Digital Village Project

DIGITAL VILLAGE Project, among others, aims at the usage of Information & Communication Technologies (ICTs) for development and empowerment of communities (mostly disadvantaged communities). The initiative aims to empower communities (that have limited or no telecommunications access) through the use of mobile technologies, which will help contribute to long-term sustainable and economic development, through Supply-Chain modules. The model will work around the human resources at the village level as an individual, family and society; working out the linkages, identification of the right stake holders, analysis of the services, working out the methodology, digital enablement with digital connectivity with the right stake holders and necessary infrastructure at the village level. The Project proposes to realize this, through the following:

- Introduce & promote Information and Communication Technologies that are cost effective and appropriate for use in rural areas, to enable rural villages digitally to access and benefit variety of services at the last-mile

- Develop and implement a Service Model wherein the villagers, NGOs and the Government work as a cohesive unit in building, maintaining and delivering the information and knowledge base to facilitate development and empowerment of the community

- Operationalise BOM (Build, Operate and Maintain) Model for incubation/deriving best practices for 2 (two) years and thereafter, a realistic sustainable ROT (Remodel, Operate and

Transfer) Model wherein all the failure entities and processes are removed, new innovation, technology updates, process optimization are introduced for 5 years

• Explore and strengthen avenues to make the service model self–sustainable at village level

• Delivery of goods and services right from the request / registration at the village level to delivery at the doorsteps, through the use of agile methods for refining the processes every time in the Service –Delivery-Life-Cycle (SDLC).

Digital Village Development Plan

In the Sansad Adarsh Gram Yojana (SAGY) (Members of Parliament Model Village Plan) Guidelines 2014, the preparation of a Village Development Plan (VDP), through a 2-Stage Participatory Planning (PP) Process is suggested for every identified Gram Panchayat (GP) with special focus on enabling every poor household to come out of poverty. This 2-Stage PP Process includes (a) Undertaking situation analysis, (b) Conducting a base-line survey, (c) Mapping of financial resources available through various programmes / schemes, (d) Mapping of natural & physical resources, and (e) preparation of Needs matrix. The SAGY 2014 programme suggests a National Level Web based Monitoring System with the specialty to upload photos of physical status of project activities.

Agricultural Resources Management

The geographical area of the country presents a large number of complex agro-climatic situations. Several attempts have been made to delineate major agro-ecological regions in respect of soils, climate, physiographic and natural vegetation for macro-level planning on a more scientific basis. They are as follows.

• Agro-Climatic Regions (ACRs)-15- by the erstwhile Planning Commission (now NITI Aayog)

• Agro-Climatic Zones (ACZs)-127- under National Agricultural Research Project (NARP) of ICAR

• Agro-Ecological Regions (AERs)-60-by the National Bureau of Soil Survey & Land Use Planning (NBSS & LUP) of ICAR;

The major focus areas, among others, will be:

• e-governance: Information on entitlements and on methods of accessing the entitlements (e.g. bank credit, inputs, etc)

• e-education: Literacy and technical skills; Digital Learning etc

• e-health: Disease prevention, detection and cure; nutrition with particular reference to maternal and infant (0-2 years) nutrition

• e-agriculture: Crops, Livestock, Fisheries (inland and marine), Agro-forestry, Forestry (Minor Forest Produce), Water and Agriculture in areas dominated by tribal communities.

• e-livelihoods: Opportunities for on-farm and non-farm employment, microenterprises supported by micro-credit, new skills and training in agro-processing and agri-business

• e-commerce: Producer-oriented marketing, quality management, matching production with demand

• e-environment: Conservation and enhancement of natural resources, with specific attention to land care, water conservation and sustainable use, conservation of flora and fauna and management of common property resources

• e-disaster management: Methods to secure investments, cope with disaster and survival in case of floods, cyclones and rare events

• e-judiciary (knowledge of legal systems and processes)

• e-traditional knowledge and practices

• e-Supply Chain platform

The Shyama Prasad Mukherjee National Rurban Mission (SPMNRM) has 14 mandatory components and other essential components as follow:

i. Cluster based skill development
ii. Digital literacy
iii. Skill training linked to employment
iv. Inter village road connectivity
v. Mobile health units
vi. Infrastructure development
vii. LPG gas connections
viii. E-gram connectivity
ix. Electronic delivery of citizen centric services
x. Public transport
xi. Warehousing
xii. Agriculture services
xiii. Agro-processing
xiv. Storage
xv. Water supply provisions through pipes
xvi. Sanitation
xvii. Waste management – solid and liquid
xviii. Education facilities upgradation

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5. Road Map for Modernising Agriculture

Technology Development – Support Framework

Technological innovations and applications, once assessed as a solution for an immediate primary problem, need to be holistically evaluated for other side effects, beneficial or otherwise. New technologies, even if technically feasible, are not necessarily economically viable at the first instance. Such viability comes from building a large consumer or user base, which requires certain financial backing. The private sector provides such funding as venture capital, after assessing the risk-reward ratio. Venture Capital (VC) funding is provided upfront by government agencies, though in a format which somewhat limits the selection, and it is largely treated as a grant.

Support by the government for start-ups that target agriculture can be structured in two ways. The first can be an unencumbered and time limited support to strategically selected technologies, such support being in the form of incubation fees, advisory and seed fund to develop and test prototypes. Such support can also be at school and college levels, and promotes innovation, at partial cost to the government, and be the first step in motivating the eco-system. After the prototypes or pilots are tested, a second level selection, for scalability of technology or of the outcome, can determine a second stage support mechanism.

At this stage, a spearheading fund can be assigned to each project for rolling out commercial or non-commercial use, for a fixed time window. The projects so supported at this stage, can allot a share of the equity. It can be expected that some projects will succeed and such equity can be exited to close the support cycle. In fact, a two stage support mechanism can be utilised for non-technology start-ups too, provided a suitable set of outcome parameters, that are modelled on equitable growth, income sharing, farmers as stakeholders, etc. are formulated. The DFI Committee proposes restructuring the Division of RKVY-RAFTAR in the DACFW to manage Agricultural Investments & Enterprise promotion. Similarly, it has suggested creation of such a Division in the Ministry’s sister departments, namely, DAHDF and DARE.

Modernising agriculture is dependent on digitalising large quantity of information, integration of the data, its analytics, and its application in agricultural activities and various practices. Farmers, cooperatives, FPOs, distributors and consumers - the entire agricultural value system comprising a myriad of actors - can be facilitated through digital technologies to work together to establish a culture of inter-dependence, inter-connectivity and traceability.

Strategic Recommendations

Digitalisation of farming system is emerging as a very important "progressive and positive" step towards achieving sustainable agricultural productivity and minimising Farmers' Distress. India requires Strategic ICT & e-Governance in Farming System Life Cycle, and the following seven disciplines need urgent consideration in the Farming Sector:

(i) Digitalised Agriculture: Digital Technology and Innovation in Agriculture: Digital India, Make in India, Skill India and Start-Up India Programmes for Transformational Reforms in Agricultural Sector (SMART Irrigated Farming, SMART Rainfed Farming and SMART Tribal Farming)

(ii) Digitalised Agro-Met Advisories & Agricultural Risk Management Solution

(iii) Digitalised Agricultural Resources Information System and Micro-Level Planning for achieving SMART VILLAGE & SMART FARMING

(iv) Digitalise the Supply Chain for about 400 agricultural Commodities

(v) Digitalised Access to Inputs, Technology, Knowledge, Skill, Agricultural Finance, Credit, Marketing and Agribusiness Management, to Farmers

(vi) Digitalised Integrated Land and Water Management System – Per Drop More Crop as also 'Per Resource Unit More Output

(vii) Digitalised Farm Health Management for reduction of Farmers' Losses

The objective to usher in an Income Revolution in agriculture by 2022-23 is possible through strategic intervention at various levels with mission mode commitments through the following measures:

i. Promote Digital India Programme in Agricultural Sector as 'Farmers' Charter'

ii. Operationalise and strengthen 'Digital Informatics Network for Farmers (DNF)' – AGMARKNET, AGRISNET, FISHNET, APHNET, NADRS, PPIN, VISTARNET, AgRIS, FERTNET, CoopNet, etc.

iii. Develop Digital Agricultural Services based on "Digitalisation and Online Internet technologies" model: Facebook, Alibaba and Uber etc.

iv. Utilise growing FDI in agricultural sector for digitalisation of agriculture to establish a robust ICT ecosystem for farming sector

v. Promote Digitalised Agriculture (Future Farming) based on GRIN Technology (Genomics, Robotics, Informatics and Nano-Technology)- Informatics include IOTs, Big Data Analytics, Geo-Informatics, Cloud Computing, Space Technology, Mobile Computing, Language Computing and SMART Farming Technologies; Create Digitalisation of Agriculture framework, as a strong foundation as the GSTN/Aadhaar framework; Adopt Open Source Platform for lowering upfront cost

vi. Operationalise Digitalised Geo-spatial Agricultural Planning & Management Database: Integrated Agricultural Resources Information System Project of NNRMS (DOS), NRDMS of DST and Sansad Adarsh Gram Yojana (SAGY), to facilitate undertaking Farm Level Plan, Village level Plan, Block level sub-sectoral plan, District Agricultural Plan, Agro-Climatic Zonal Plan, Agro-Ecological Plan etc., so as to achieve highest level ROI (Return on Investment)

vii. Establish Digitalised Agricultural Risk Intelligence Framework for assessing risk and risk profiling at farm level, regional level as well as at national level including appropriate advisories for risk mitigation, through installation of about 20,000 Automatic Weather Stations (AWSs) for collating real-time weather data from Panchayat level, assuming that a weather station can be representative in about 5 km radius. Also ICT enabled process to realize Agricultural Crop Insurance entitlements to farmers

viii. Set up Digitalised Farm Health Management Information System integrating plant health, soil health, water health and fishery health – One Health/Eco Health – at farm level

ix. Establishment of Centre of Excellence (COEs): National Centre for IT in Agriculture (NCITA), State Centre for IT in Agriculture (SCITA), District Centre for IT in Agriculture (DCITA), to undertake transformational technological interventions for digitalisation of Farming, and Block Centre for IT in Agriculture (BCITA); COE on Data Analytics & Modelling to achieve Big Data Analytics of Agricultural Things (BDA-AoT) and Mission Critical Big Data in Agriculture and also to monitor agricultural production and trade (domestic and international); Agri-clinics and Agri Business Centres, to provide Knowledge, Technology, Inputs and Marketing, as Agri-entrepreneurs and link them to Centre of Excellence (COE) as visualised

x. Bridge the development gaps in Human Resources Development for Digital India in Agriculture– Agricultural Informatics Professional – through M. Tech / B. Tech in Agricultural Informatics Courses in Rural India

xi. Introduce Big Data Analytics in the Directorate of Economics and Statistics (DES) of the Ministry to build DSSs facilitating Analytical, Transformative and Discovery Path to agricultural policy making; and also extend the land use statistics data, under nine fold classifications, to village / panchayat level

xii. Undertake Capacity Building and Competency Development on Digital Technology of Farming Community, through Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA)

xiii. Develop Agricultural Constellation of Satellites to provide data in high resolution, with 1-2 day frequencies, in different domains: optical, thermal and microwave

xiv. Formulate, finalise Agricultural Drone Policy for collecting high resolution imageries for agricultural risk management and mitigation, of UAVs by public and private sector providers to support precision agriculture in India, by incorporating appropriate clause in the Draft National Geo-Spatial Policy (May) 2016; and also to facilitate Start-Ups to build high resolution imageries based advisory services

xv. Develop a national programme for Integrated Use of Space Technology in all domains of agriculture

xvi. Replicate model projects such as Farm Beats of Microsoft, Digital Drip Irrigation System Tool Box of Israel, ICRISAT Framework for Digital Agriculture (Agricultural Value System and On-Farm Management) for Small and Marginal Farmers; Netherlands Model of Farm Data Analytics; Ramthal Project of Jain Irrigation Systems; New Zealand Model of "Digital tracking, reporting and monitoring: Future of Our Fisheries", suitable modifications may be effected

xvii. Establish Digitalised Access to agricultural credit and financial services, logistics and warehousing

xviii. Build up Digitalised Agricultural Value Systems for 400 agricultural commodities involving farming community (including one for kiwi fruit of Arunachal Pradesh)

xix. Establish Digitalised Agro-Marine Clusters and Agro-processing Clusters based Value-Chain at Block level, under the PM Kisan Samapada Yojana (PMKSY)

xx. Undertake seamless integration of e-NAM with AGMARKNET Portal to enhance transparency and reduce the Market Information Asymmetry in the Agricultural Marketing System, and above all, to help in containing price volatility and undertaking appropriate policy decisions

xxi. Upgrade 2G and 3G Networks to 5G Network in Rural India to operationalise Digitalised Farming and its associated Workflow Process with IoT and Drones; 5G Bandwidth is very important for IoT Applications

xxii. Introduce Private-Public-Partnership (PPP) initiatives to Operationalise "technologies for agriculture" which are being developed in a fragmented manner, and are at various stages of development

xxiii. Create All India Coordinated Research Project (AICRP) in ICT in Agriculture in ICAR, in which Engineering Colleges (4500 Engineering Colleges, NITs and IIITs who teach Computer Science and Information Technology etc) may also be included to undertake focussed research projects in the area of IoT, Big Data Analytics AI, Space & geospatial Technology and Cloud Computing in the area of Agriculture and Food Sciences - Sensor based Decision Support System for Soil Micro Nutrients, IoT framework design, specialised sensor development, data acquisition models, Algorithm design, Knowledge generation and site specific decision support etc.

xxiv. Create 3D Printing facilities in KVKs to enable agricultural mechanization in a big way in small and marginal farm holdings

xxv. Establish High Performance Computing (HPC) in selected Central and State Institutes for manipulation of very large data sets, particularly related to agricultural genomics, proteomics, geo-informatics and climate change, in collaboration with Ministry of Electronics and Information Technology (MeitY)

xxvi. Undertake collaborative ICT4Ag Projects in the Hub-Spokes Model involving ICAR-NARS, Academic and Research Institutions (IITs, NITs, IIITs, Universities, Deemed Universities, Engineering Colleges and other Institutions of Higher Education etc.), Industry-Institutions and End Users; and also Establish a Clearing House Agency (e.g. MANAGE, NAARM or proposed NCITA) to be the Arbitrator for ensuring success of Hub and Spokes Model and adopt ICT enabled Extension Services

xxvii. Generate site specific land resources inventory(LRI) and suitability using GIS and remote-sensing techniques for enabling the developmental departments in scientific land use planning (planning, implementing, monitoring, reviewing and evaluating all the land based agricultural developmental projects) at the level of a watershed or a river basin

xxviii. Formulate a Satellite Imagery Strategy for Agriculture by ISRO, in collaboration with Indian Council of Agricultural Research (ICAR), State Agricultural Universities and other Development Stakeholders, to enable accurate and timely Spatial Application Information Utility Tools, in convergence mode, for direct benefits of farmers especially Small and Marginal operational holders who are more than 85 % of the farming community in India

xxix. Undertake Geo-tagging of Agricultural Assets - ponds, markets, cold storages, marketing structures, crop area, watersheds, warehouses, laboratories etc., for their real-time monitoring and effective utilisation and impactful advisories.

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6. Structural Reforms for Higher Efficiency

Shifting the Production and Income Curves

The strategy essentially advocates transforming agriculture into agri-business, which means that the outcome of agriculture should preferably be measured in terms of income returns per unit of asset (land/waterbody/livestock/bird etc.) as against measuring it in terms of production per unit of asset. The strategy then argues for improving productivity, reducing cost of cultivation/production and realising remunerative prices on the produce, for net positive returns at the farmer's level. While various interventions suggested in the pre-production, production and post-production stages will bring in greater efficiency and result in higher returns to the farmer, the inherent bottlenecks that plague the agricultural structure in India today, do not permit the factors of production to play up fully and contribute at their optimal level. The operational efficiency realised even under best circumstances of implementation is likely to be linear and hence incremental in impact.

Operational efficiency in agriculture can be defined as the ratio between an output gained from an agricultural activity and an input used to run this activity. When improving an activity's operational efficiency, the output to input ratio improves and should drive agricultural policy.

Inputs would typically include water / fertilizer, etc., money, man-power (measured as headcount or as the number of full-time equivalents) and time / effort. Outputs would refer to the harvested grain, fruit, vegetable, milk, meat, fish, fibre, by-products and other material. Both require to be computed in terms of value and not only in quantity. It is possible to shift the production curve, as also the income curve to the next higher level by identifying and addressing the systemic constraints.

There exist certain structural weaknesses, which when appropriately addressed will mean the enhancement of the genetic potential of the factors of production; and expansion of the space for these factors to express more wholesomely. Thus, the same intensity of operational interventions will bring more visible results in the following ways:

- efforts made to achieve higher productivity will shift the productivity curve;
- initiatives undertaken to achieve resource use efficiency will result in greater resource saving and cost saving; and
- measures taken to improve marketing efficiency will yield higher returns on output.

Basic Constraints Facing Agriculture Sector

Land, labour and capital have for long been recognised as the principal factors of production. These also constitute the factors of production in industry. However, what differentiates these two sectors, making agriculture much more complex is its biological nature. While in case of a production system based on mechanical processes, the variables can be controlled, and hence, there exists the scope for manoeuvring the demand and supply, agriculture sector suffers from lack of this opportunity.

Being biologically dependent, the variables like climate & weather and their ramifications (temperature, humidity, rainfall, etc.) which are external to the management system are not manoeuvrable. The downside of this is, that the investments made in the factors of production by a farmer are irrecoverable and the outcome is more a matter of chance. The statistical probability of success is at best 50:50, and in reality is worse-off, most of the time.

Important Structural Weaknesses

The target of doubling farmers' income by 2022-23 is only a first radical step, engendering a fundamental shift, to the way agriculture has so far been perceived and practiced in India. If the agriculture sector is to respond suitably to the redefined mandate (DFI Volume-VIII), it will require continuous transformation, so that it acquires the characteristic of agri-enterprise, whereby farmers take to agriculture as a chosen option, and are able to earn their livelihood as entrepreneurs and simultaneously cater to the country's strategic requirement of food security.

It is in this context, that some basic structural issues are identified, so that appropriate reforms can be effected. These are:

i. Land divisions and fragmentation.
ii. Definition of a farmer - many exclusions.
iii. Uncontrolled variables - production risks and market unpredictability.
iv. Controlled regime – difficulty in doing agri-business.
v. Agricultural policies – holding back income growth.
vi. Infrastructure constraints – limiting the market and income growth.
vii. Climate change – complicating the agriculture.

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7. Structure of Land Holding

Changing Agrarian Structure

Today, Indian agriculture is dominated by small and marginal farmers, who account for more than 86 per cent of the total number of landholdings, that counted to 11.88 crore as per 2011 census. The net arable land measures 141 million hectares. The number of land holdings have been steadily increasing since 1951, when they were 6.99 crore in number. In the year 1995- 96, number of holdings were 11.55 crore and the average size of holding was 1.41 ha. and by 2010-11, the average size declined to 1.15 ha. The country's population has been increasing steadily since independence and the dependence on agricultural output has only increased.

While the population dependent on agriculture for livelihood has come down from more than 70 per cent in 1951 to 48 per cent by 2011, in absolute terms, the number of families and the number of holdings have only increased. The NSSO's Situation Assessment Survey (SAS), during the agricultural year July 2012 – June 2013 shows that, of the estimated 15.61 crore number of rural households, the number of agricultural households stood at 9.02 crore, accounting for 57.8 per cent of the former.

Further, of the 86 per cent of the small and marginal land holdings, the majority are marginal (equal to less than 1 ha. in size). The small size of land holdings is a challenge by itself, which is rendered more complex by its fragmentation. While land division is linked to law of inheritance, fragmentation is associated with the practice of dividing and sharing every piece of land among the inheritors.

Most farms in India are thus family farms, sometimes referred to as 'handkerchief size' holdings. It is important to note, that land size has a bearing on production, input costs and final income. The income from operational efficiency is influenced by the size of land holding. It is difficult operationally to individually harvest the scales of economy at both production and post-production stages, and this adversely impacts the costs of production and transaction.

Land Size and Income

As per NSSO's 70th Round, the average annual income of an agricultural household came from four (4) sources, namely, cultivation, livestock, non-farm business, and wages & salaries. The average annual income was Rs. 77,976 in 2012-13. The average ratio of farm to non-farm income as a proportion of the farmers' income was 60.20: 39.80 (60:40 approx). It is relevant to observe, that the ratio of farm income was directly correlated with the size of the landholding (categorised as marginal + small, medium + semimedium, large) as presented below:

• The income ratio from cultivation increased from 36.5 per cent (marginal + small) to 70.8 per cent (medium + semi-medium) to 85.5 per cent (large).

• The income ratio from livestock declined from 14.8 per cent (marginal + small) to 11.5 per cent (medium + semi-medium) to 6.9 per cent (large).

• The income ratio from wages and salaries declined from 37.5 per cent (marginal + small) to 13.0 per cent (medium + semi-medium) to 3.2 per cent (large).

• The income ratio from non-farm business declined from 7.2 per cent (marginal + small) to 4.8 per cent (medium + semi-medium) to 4.4 per cent (large).

It is obvious, that size of the landholding impacts the percentage of income that accrues to the farmer. It therefore, has a say on the viability of farming and the status of farmers' income.

As per the same NSSO 70th Round (July 2012 – June 2013), while the average monthly income of a farm household in 2012-13 was Rs. 6,426, the average monthly consumption expenditure was Rs. 6,223, leaving a paltry surplus of Rs. 203. That, farmers owning upto 1 ha. of land are not able to balance their farm budget is also clear from the same survey.

Among various sources from which the agricultural households derived at least some income during 365 days prior to the date of survey, the source that yielded the maximum income was taken as the principal source of income. As clear from figure 2.1 below, agricultural households were mainly dependent on cultivation followed by wage / salaried employment for their livelihood, as about 63.5 per cent of the agricultural households reported cultivation, and 22 per cent reported wage / salaried employment as their principal source of income.

Land Pooling and Improving Land Use Efficiency

Since independence, agriculture has been recognised as a primary activity that supports majority of the Indian population. In the absence of the ability of non-farm sector to absorb surplus manpower that is now engaged in agriculture, the primary sector has continued to be the principle livelihood provider to a vast majority. It is only since 2005-06, that a small shift of people from agriculture to non-agriculture sector has been noticed. In result, the number of cultivators has decreased from 12.73 per cent in 2001 to 11.88 crore in 2011.

Further, both the society at large and successive governments in particular have treated land as the primary asset, and that, as many families as possible should have access to it. The country's constitutional commitment to socialism has meant that land, the primary asset should be equitably distributed. It is this philosophy that has inspired the states to adopt progressive Land Revenue Acts, that:

• lay down the maximum land ceiling beyond which a citizen cannot own agricultural land;

• tiller shall be the owner of the land;

• a person with non-farm income beyond a certain threshold is barred from purchasing agricultural land; and

• a person not already owning a piece of agricultural land is barred from purchasing one.

These provisions have, in the past, helped the landless as also the tenants, sharecroppers and lessees to gain ownership and unhindered access to land, thereby incentivising them to invest in agriculture, adopt new technologies and farm management practices, and produce more. Amongst other adoptions (high yielding variety and hybrid seed, fertilizer, water and procurement of the produce at MSP) that constituted a positive policy framework ushering in green revolution in the country, pro-people land reforms too provided a strong platform for India’s celebrated agricultural revolution.

However, the contemporary antidote to the non-viability of farming, arising from continuing land division & fragmentation, seems to be the facilitation of land pooling. The very laws that had earlier driven a positive change in the socio-economic status of large number of cultivating class, by enabling a more robust production system, are in some ways now seen to be becoming an impediment to sustaining the pace of that progress.

Land Pooling via Farmers Mobilisation

Indian socio-economic ethos and constitutional spirit do not admit of reverse exchange of land ownership, however forceful its need or appropriateness may be. No argument for it can hold water, given the large majority of people dependent on cultivable land and related agricultural activities; and the inability of the non-agricultural sector to absorb surplus manpower of high magnitude. Against this backdrop, there exists a strong case for designing alternate ways of land pooling, without breaching the spirit of equitability of asset ownership at the societal level, and without compromising the deed of right, title and ownership at individual level. This would aid in enhancing operational scales and resultant efficiency.

Other Land related Issue

Land Management has continued to be challenging and the owners are never at ease on account of a plethora of issues. There is need for resolving all these and given the power of technology - IT, ICT, geo-spatial technology etc., it is much easier today to surmount the long standing land related challenges.

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8. Farmer for Inclusiveness

Agricultural workers

Agricultural Statistics defines agricultural workers to include cultivators and agricultural labourers. In the year 1951, the total numbers of agricultural workers were 97.2 million (cultivators 69.9 million + agricultural labourers 27.3 million). There was a steady increase in respect of both the cultivators and the agricultural labourers from census to census conducted decadally till 2001, when the total number of agricultural workers rose to 234.1 million, comprising 127.3 million cultivators and 106.8 million agricultural labourers. As per 2011 census, while the total number of agricultural workers rose to 263.1 million, the number of cultivators declined for the first time to 118.8 million and agricultural labourers increased to 144.3 million. It is indicative of the shift of cultivators between 2001 and 2011 to nonagricultural activities. It is also possible that some cultivators may have joined the ranks of the landless labourer.

The nomenclature of 'agricultural worker' for a cultivator may not be appropriate. It needs to be appreciated, that a cultivator is an entrepreneur, who manages his land or livestock like an industrial entrepreneur. To a cultivator, management of his asset involves decisions relating to input and output, and negotiating several risks associated with largely a biological activity that agriculture is. The cultivator or a livestock keeper, therefore, needs to be recognised as an agricultural entrepreneur. The National Commission on Farmers (NCF), 2007 in its Report considered both land owning cultivators and landless agricultural workers as farmers. However, no specific recommendations were made to improve the welfare of the landless agricultural labourers.

As regards cultivators per se, not all cultivators are currently recognised as farmers in reality. A farmer is largely perceived to be the one who owns cultivable land, whether he is cultivating it himself or not; or even directly managing it himself or not. While majority of the cultivators are land owners too, a substantive number of cultivators are not land owners. And therein arises the problem of exclusion of many an actual cultivator by the currently recognised definition of a 'farmer'.

To all intents and purposes, a farmer is one who owns land and possesses a revenue record that establishes his right, title and ownership. This record of right (RoR) is the 'certificate' that offers him a right to access all benefits – material or otherwise, that the government provides through large number of its schemes, programmes and missions. The institutional credit – both short term crop loans and long term investment loans are also available based on RoR. The tenants or lessees or sharecroppers are not considered as eligible to avail of institutional credit. The only exception though, is when the farmer becomes a member of a Joint Liability Group (JLG), a group of 10 members. Promoted by NABARD, there are about 1 lakh JLGs in the country, which means a marginal coverage of farmers and cultivated area in the country. Similarly, the relief measures under the Relief Act are also accessible only against RoR.

The vision of the Government is to double the income of the farmers. The DFI Committee focuses on strategy to improve farm incomes, and therefore, does not directly address the issues relating to the welfare of the landless agriculture labourers, who constitute a large section of the rural society. It may not mean much just by including them (144.3 million, census 2011) under the class of 'farmers', as they will need to be addressed separately, since their livelihood issues, while linked to agriculture differ in many ways and are unique to them as a class. However, the strategy recommended by DFI Committee is expected to generate additional job opportunities for the landless labourers too in multiple agricultural activities and contribute to their welfare. Further, the farmers earning higher net incomes can also be expected to pay the agricultural labour at a higher level.

Various benefits like seed kit, fertilizers, pesticides, farm machinery, micro-irrigation, land development, etc. are given to the one who can prove land ownership. As a consequence, the actual cultivator like the lessee, share cropper, tenant, etc. who are in reality substantive in number stand to be excluded from the system of benefits and entitlements. The outcome is, that the objectives of the government intervention, which are all meant to improve the status of agriculture in the country may not be equitable and inclusive.

Purely from the perspective of developing agriculture and ameliorating the condition of the farmers, the actual cultivator also must be recognised as a farmer and rendered eligible to all the benefits under various schemes / programmes / missions, as also institutional credit and relief measures. Under the provisions of Land Reforms, the tiller is considered as owner, precisely to promote agricultural development, for it is believed, that the owner of the land will demonstrate greater commitment to professional management. However, a situation has arisen now, where more than 65 per cent of the landholdings are less than 1 (one) ha. in size. Most in India still perceive land as a valuable asset and the owners may not be willing to give up ownership and tend to cling on to it. Probably, a sense of security and emotional attachment blend together, to enhance the land-centric sentiment among most Indians. It may only be much later in the future, when those whose principle source of income is not from farms and are earning enough from their salaries or business / service, that they may want to dispose off their small pieces of land, helping land consolidation as a sequel.

For the present therefore, it would be practical to liberalise the definition of farmer by including both the land owner, and the one not owning but cultivating it as a lessee or sharecropper or in any other way, under the definition of a farmer.

Norms based Definition of Farmer

In the above context, it is suggested that certain norms be identified to define a farmer, rendering him/her eligible for all agriculture related benefits. Further, the list of farmers can be dynamic, which means that there can be both entry and exit options, based on the actual status of ownership and / or cultivation. Some of the norms suggested are:

i. Ownership of land and/or actual cultivation.
ii. Agreement with the land owner to the effect that he/she is a lessee / sharecropper, etc.
iii. Eligibility for the period of agreement of lease, etc. with the land owner.
iv. Gender of farmer.

A portal may be developed to enable the owner and lessee, etc. to post their status, accompanied by relevant document(s). A database can be maintained by the local Revenue Officer or Gram Panchayat or the local Agriculture Officer. An annually authenticated village-wise database can be made accessible to the officers of the departments of Agriculture, Horticulture, Animal Husbandry, Fisheries, Banks, Cooperatives, Relief, etc. who are then free to offer eligible benefits to newly defined farmers.

A web enabled application will enable the interested parties to update their status from time to time by using their mobiles or laptops / desktops or when they do not own one, can do so from citizen service centres (CSC) or Gram Panchayats and the like.

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9. Uncontrolled Variables - Production & Market

Agricultural and Industrial Production

The process of agricultural activities across crop production, livestock & dairy, poultry, fishery etc. are all nature-bound and hence, influenced by variables external, that matter to the cultivator in respect of production, productivity, pest and disease management, resource use etc., and are difficult to be regulated unlike in the industrial sector. The latter, which is a mechanically driven process, also depends on various factors of production for the manufacture of its output, these nevertheless, to a greater extent, are amenable to control and change.

Wherever the factors of production and related variables are manipulable, there exists scope to regulate the supply in consonance with the expected demand. This is a big advantage that a manufacturing sector enjoys vis-à-vis a biologically driven activity like that of agriculture. Regulation of supply implies that the production can either be increased by enhancing the capacity utilisation to meet the expected increase in the market demand or it can be reduced if the demand is likely to be subdued.

In contrast, in agriculture which is more an open activity, bound by seasonality, there is a fixed time (limited window) to begin the production operations and once this operation is rolled out it cannot be held back. Seasonal nature is characterised by binary system of 'Yes' or 'No'. When it is time to sow / plant / harvest, the farmers either does it or does not and miss the opportunity. Hence, the farmer is always dragged down by an Hobson's choice. Inability to regulate the supply in accordance with the dynamic changes in the market negatively impinges on the ability of the farmer to monetize his produce appropriately.

Not only is the process of production irrevocable once it is rolled out with the first activity of sowing / planting, but also the crop is subject to multiple vulnerabilities like variations in temperature, rainfall, humidity, etc. Every crop has its own critical stages in production, at each of which water the critical input is highly necessary. If the monsoon fails at this critical stage of crop growth and there is no dependable source of water to meet the obligatory demand, then the crop is bound to suffer in terms of vegetative growth as also its final yield. The weather pattern also influences the probability of infestation by pests and diseases. As seen thus, all kinds of cropping programmes face uncertainty. Likewise other agricultural activities like dairying and livestock, poultry, fisheries etc. are also vulnerable to external weather patterns.

Multiple forms of Natural Calamities

Nature wears multiple facets of natural calamities, adversely impacting all types of agricultural activities. These include drought, flood, hailstorm, whirlwind etc. Some areas in India are more prone than others to natural calamities and in result face greater uncertainty of realising a normal yield.

Negative Impact of Production Risks

Any kind of risk deters a farmer from making recommended investments necessary to realise optimal yields. A situation of greater certainty always bears a positive impact on any agrientrepreneur. The losses that a farmer meets from a natural calamity are huge.

Already in the low income bracket, the farmer is pushed to the precipice. His savings if any, melt soon and the farmer is left with no capacity to meet the subsequent season production investments. The probability of his indebtedness increases.

Negotiating Market Unpredictability

The supply in agriculture system is relatively fixed, and is therefore, not amenable to regulation in harmony with the changing market dynamics. However, it is possible to make certain interventions post-the-harvest to regulate the release of commodity into the market based on price situation.

One of the major problems that farmers face today is distress sale on account of their weak capacity to withhold their stock, pressed as they are to dispose-off their produce immediately to meet debt and consumption expenses. Even when some farmers are capable of withholding their stock from immediate sale, they may still not be able to do so due to perishable nature of certain agri-commodities (particularly fruits, vegetables, milk, etc.) and absence of appropriate logistics systems in close proximity.

In order to help the farmers to hold back their produce and decide on its time, place and form of sale, enabling systems, technology and infrastructure should be put in place. Some suggestions in this direction are as follows:

(i) Enhance availability of post-harvest loans at concessional rates, so that the farmers can avail of pledge loans for a certain period. The pledge loan system warrants a strong network of accredited warehouses in close proximity to the farm gate so that the farmers can transport and store at minimal costs.

(ii) Strengthen agri-logistics in terms of pack-houses, dry and cold storages, dry and cold multi-modal transportation network. This will help the farmers to precondition, transport and store their commodities, of their own volition, in a safe and secure manner in right time and to places where they can fetch better prices for their produce. The logistics components, identified to be of critical importance, may be given special capital interest subvention to motivate investment and offset shortfall. There will then arise a strong system of connect between production and consumption centres.

(iii) Processing facilities, both small and large scale, can further help the farmers in realising better value on the surpluses that cannot be consumed in fresh form in both near and far markets. It is, therefore, necessary to strengthen food and non-food processing facilities. Such industries, typically hold and stock nventories for their processing needs, and can be developed as a channel to facilitate post-harvest loans to farmers.

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10. Trade Regime and Export Promotion

Among various factors, farmers' welfare is also hinged to their earning optimal and positive net returns from agriculture. This necessitates realisation of remunerative prices on the produce. Given that an ideal market situation, particularly in the agricultural sector, is difficult to achieve, non-market interventions in support of the farmers become inevitable.

Given production growth and the untapped opportunity from enhancing productivity, marketing opportunity for the produce have to be expanded beyond the domestic frontiers. Higher production will require that the export potential be harvested. Indian agriculture under the WTO regime is already integrated with the global market. Agreed upon market access protocols and Trade Agreements with other countries also ensure the scope for import and export of agricultural commodities.

Trade Policy used to Control Domestic Prices

A cursory look at the 'Agricultural Trade Policy' and tariff changes over the last decade, will show that there have been frequent and short term adjustments. More currently, they can be called as knee jerk reactions. Some examples are provided in chapter 5 of Volume-IV of the DFI Report. The examples demonstrate that, both on the import and export sides, the policies are changed frequently, interrupting the trade windows and trading relations. Long term market relations are put at risk when trade policy is varied in the short term and is unstructured in nature.

The trade policy for agriculture is approached as a price support and price stabilisation tool, but its use is mainly tilted to favour consumers. On various occasions, a sudden reduction in import tariffs due to an increase in consumer prices is evidenced, and they harm the immediate interests of farmers, since the cheaper imports tend to offset the economic welfare of farmers by causing a dip in market prices.

Similarly in case of exports, trade policy is used as an internal price control mechanism, to adjust tariffs to curtail any increase in consumer prices. The Minimum Export Price (MEP) is used as a tool to restrict or ban the export of a commodity in reaction to rising prices in the domestic market to protect consumer interests once again. In either case, the agenda is to control the supply of an agricultural commodity to the domestic market, to adjust temporary demand-supply imbalances.

The frequent changes in export and import policies are often triggered by concerns of consumers' unease over domestic prices. The effect is a short term shift in supply and market value, but this in turn, causes disruptions in the production plans of farmers. Such disruption can have long term implications, as they tend to affect next season's cropping plans, resulting in an unhealthy cobweb of production, price and trade.

The agricultural trade policy is not seen to promote agricultural trade, but is mainly used to control prices in the domestic market, in reaction to short term circumstances

There may be certain benefits in achieving this, but there is need to have an Agricultural Trade Policy that supports and promotes linking Indian farmers with the global market. The agricultural trade policy should be guided by balancing the interest of both the producers and the consumers, in addition to long term food and nutritional security concerns of the country.

Agricultural Trade Policy to Promote Trade

There is no long term approach to Agricultural Trade Policy in the country, unlike the Foreign Trade Policy announced by the Department of Commerce which usually takes a long term view (3 years at present). As a supply control mechanism, short term adjustments in tariff and export windows tend to disrupt any planning, or relationship building in international trade. Agriculture is already unpredictable, subject to vagaries of nature on the domestic front and markets uncertainties. A short term view of trade policy only adds to the existing risks and uncertainties.

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Agriculture

Chapter 9

Short Answers

CSM-05: Compiled by Prof. Ashok Vishandass

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This chapter contains:

- Restrictive Policies- Liberalisation
- Infrastructure constraints
- Climate Change – compounding agricultural risks
- Farmers' Welfare
- Planning and Review – Institutional Arrangement
- Grassroots Level Participatio
- Investment Pattern in Irrigated and Rainfed States
- India - Subsidies in Agriculture
- Inflation Management
- Mobilising Farmers

Contents

1. Restrictive Policies- Liberalisation

Why Liberalisation?

The production system is a function of deployment of various inputs. Of the several inputs deployed in agriculture, some of the more important ones are seeds, fertilizers and pesticides. The latter two include both inorganic and organic based. The cost of cultivation / production is determined amongst others by the quality of the inputs that the farmer purchases and the price at which he makes the purchases. The shift of farming from the traditional / conventional system to the modern has linked agriculture to marketing more than ever before.

A large part of the agricultural production system today is driven by market forces. The farmer purchases most of his/her input materials like seeds, nutrients and pesticides from the market. Hence, both quality and cost of inputs become critical, if the overall cost of cultivation is to remain rational and help increase the net farm income.

As regards post-production management, the environment for handling and monetising the agricultural outputs has to be conducive enough to encourage capture of optimal value and enhance the farmers' reach into markets.

An open and liberalised environment for manufacturing and distributing the inputs is likely to introduce competition and offer alternate options to the farmers to make a choice. It is also likely to incentivise innovations for introduction of new and more suited types of inputs, and also make them available to the farmers at a more reasonable cost, as a result of competition. However, some regulation will be required to ensure that these critical inputs are available at right time, in accordance with right quality and at rational price. There has to be room for checking any probability of malpractice. After all, these inputs are critical to crop and livestock production and therefore essential in nature.

Output management encompasses rules relating to trade & stock limits, and scope for free market. Hence the need for a more liberal regime of stock limits and policies that facilitate market participation by a wider stakeholder base.

Reforms in Critical Inputs and Markets

There are 3 (three) critical inputs, that need to be addressed for making them available to farmers at cost-competitiveness and in adherence to quality standards. These are:

- Inputs

- ♣ Seeds
- ♣ Fertilizers
- ♣ Pesticides

• Market Reforms

Seeds are the seeds for growth

Seed constitute the starting point of a crop production system and the vigour & quality of seed circumscribes the limits of output can one can harvest. Of course, it is equally important that a conducive growth environment is provided for the seed to express its genetic potential wholesomely. India's seed industry has grown appreciably in size and level of performance in the past five (5) decades. Both private and public companies / corporations are involved in production of seeds.

Recommendations for improving the seed sector

There exists lot of scope in effecting improvements to the existing seed production system in particular, and seed sector in general. Some following suggestions are made in this context:

i) Need for higher Seed and Varietal Replacement Rate

For achieving the desired levels of Seed Replacement Rate (SRR), adequate seed of good variety has to be produced. Each state needs to prepare a State Seed Plan to meet the region – specific requirements. The list of recommended varieties must be revisited and finalized in consultation with the scientists of the State Agriculture University, ICAR Institutes in that region, Crop Coordinators, State Agriculture Department officials and the seed producing agencies. Seed production programme should be organized in each State under a comprehensive and integrated State Seed Plan appropriate to different regions. The states should ensure production, multiplication and replacement of seed to increase VRR and SRR progressively, particularly in respect of regionally important crops/varieties. Varietal Replacement Rate (VRR) is as important as SRR.

ii) Replacement of older varieties with newer varieties

A review of existing list of released and notified varieties reveals that many old varieties (more than 15 years) still find place in the recommended package of practices. Continued use of old varieties is non-productive, and should be replaced by new ones, and must be brought into seed chain system on priority. SRR does not ensure high productivity if the variety is old and has developed vulnerabilities to external factors. A rigorous exercise to weed out all old varieties should assume priority.

iii) Promoting hybrid technology

Promotion of hybrids/ HYVs of major field crops should receive a high priority, so as to bridge the productivity gap and increase production. In this context, both public and private sectors have to play a major role, as seen in the case of maize. For accelerating hybrid seed production, the present system of receiving indents of notified hybrids by the public/private sector needs revision by including larger number of indents for the parental lines of the hybrids.

iv) Public-Private Partnership (PPP) Models

Partnerships between the public research institutions and private sectors are desired in R&D, as also production and distribution of seeds to the farmers. A collaborative technology park for carrying out research for development of new varieties may be established by adopting PPP models.

v) Use of Intellectual Property Rights (IPRs)

The facility of IPR for new and innovative technologies can incentivise investments in R&D in both public and private sectors. Public sector research system should also protect its varieties through PPV & FR Authority and generate the revenues which can be ploughed back into the system as R and D investments.

vi) Stronger enforcement

The Seed Law Enforcement wing of state governments needs to be strengthened. The Seed Inspectors have to be well trained for effective enforcement of various provisions of Seeds Act, 1966, Seeds (Control) Order 1983, Environment Protection Act, 1986 and Consumer Protection Act, 1983. They will need continuous upgradation of knowledge to be effective in checking spurious seeds. In addition, there is need to deploy suitable technology like bar coding etc. Adequate number of seed testing laboratories are also needed.

vii) Strengthening of Seed testing facilities

Most State seed testing laboratories suffer from inadequate manpower and poor infrastructure facilities. They are required to be strengthened both in terms of manpower as well as technical capabilities. Their performance has to be monitored periodically with reference to the preciseness and reproducibility of the test results.

viii) Uniform procedure in the country for seed licensing

Under the Seeds (Control) Order 1983, every seed dealer has to obtain the license from the State Licensing Authority. Under Clause 5 of the Seed (Control) Order, a licensing authority after making such enquiry as it thinks fit can grant a license to an applicant. This provision is interpreted differently by the state governments, seeking varied nature of information/documents which is not a business-friendly environment for those companies doing business is more than one state. It would be useful if central government develops a Model Guideline and Procedure for the states to adopt the same.

ix) Enhancing export of seed

India has the potential to become a leading player in seed business if it can tap the demand in developing world. Many of these countries have limited availability of hybrid seeds and the Indian crop germplasm has light potential of adaptability in these countries. This is a huge business opportunity available to the Indian seed players. The present share of India in global seed market is less than 2 percent, which can be easily scaled up by harvesting the market in African, SAARC and South-East Asian countries. India can achieve the target of 10 percent of the global trade by 2020, as envisaged in the National Seeds Policy 2002. Some of the Indian / MNC seed companies are already doing business in some of these countries, which can be further expanded. For this to happen, the seed industry will need to be facilitated by simplifying the procedures for obtaining export permits etc. Further, the EXIM policy has to be steady over reasonable period, for private traders to establish long term business relationships.

x) Seed Quality Assurance

Seed quality assurance requires considerable investment in terms of proper infrastructure, equipment and competent human resource. Seed certification agencies, have to be adequately equipped and made more efficient for certification of quality seeds. The Seed Testing Laboratories should be strengthened and accredited by the International Seed Testing Association (ISTA).

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2. Infrastructure constraints

The status of infrastructure, 'in' and 'for' agriculture, plays a prominent role in the pace of change that can be achieved in agriculture. Investment in basic support infrastructure, such as roads, irrigation, electricity, etc., is critical to achieving of the desired higher growth rates. This support infrastructure is the back-bone for other infrastructure components in agriculture, such as markets and the associated agri-logistics.

The basic support infrastructure not only facilitates production and productivity, but also provides the platform to build backward and forward linkages, between farms and markets. Without such facilitation, the farmers and the nation stand to lose on the gains made through productivity enhancement and production growth. Investment in infrastructure is evidently important to enhance the technical and financial viability of farming, from angles of both agribusiness economics and sustainability.

Absence of infrastructure is a basic constraint and needs to be addressed. It must also be understood, that private corporate sector investment also follows public expenditure in rural roads and energy. Data shows that the bulk of private sector investment in agriculture has happened by farmers themselves. This investment is largely for their enterprise related activities like land development, small irrigation etc.

Public investment in rural connectivity (roads, transport, electricity, communication) allows for a growth in the traffic of agricultural produce, from farms to markets. Greater involvement of the corporate sector is desired to organise and integrate the flow of agricultural goods and commensurate value. This optimal blend, in turn, organises the overall input and output supply chain making for an optimised agri-value system. The current measures of marginal effects, from public investment in rural roads-transport, energy and communication, on farmers' income, may not be fully capturing the growth from associated investment in agri-business, marketing, and the growth in productivity that also accrues.

The accelerated momentum in public investment needs to be increased to achieve the targeted rate of 16.45 per cent, spread over the various heads in agriculture. A holistic approach to fill the gaps and bring convergence in the resources available across different public sector agencies, as also in the private sector should be adopted by the states. For example, investment in irrigation and energy must be met with commensurate investment in roads and in modernising marketing infrastructure. An apt measure of outcome to adopt is the growth in income or the total quantity of production trafficked.

A good strategy to adopt is to have private investment targets linked to public investment spending. Currently, the added investment in the seven years after 2015-16, by public and private sectors, is Rs. 102,269 and 46,298 crores respectively (a ratio of 1 : 2 approx.). Apart from ongoing private investment by farmers, these is little investment by corporate sector. Since, corporate private investment would, to a significant level, be linked to availability of basic infrastructure, the States can have a target equivalent to at least 10 per cent of the public investment made in agriculture. This will drive emphasis on making public investments in appropriate supporting infrastructure, as needed by the private sector to plan and make their own investment in agri-business projects.

Public investment measures can include factors or indicators that link to increased corporate sector investment in agriculture, especially in agri-business areas (market upgradation, agrilogistics, agro-processing, etc.). This will also bring about an increase in the marginal effects of public investment and lead to greater use efficiency of public capital invested.

This Committee has recommended a Division of Investments and Enterprise as part of restructuring and reorganising of Divisions in the Ministry of Agriculture and Farmers' Welfare. A similar approach is suggested to the States. It must be noted that guiding public investments 'for' agriculture and promoting investments in agricultural enterprises and will be vital to achieving the agenda of doubling farmers' income. It is noted that currently the scheme implementing agencies, whose achievements are guided by financial and physical targets, are also loaded with related policy formulation responsibilities. This, at times tends to disallow the necessary holistic intent and outcome based approach in policy making. Segregating implementation activities from policy making, will help make the policies more outcome oriented and allow for better monitoring of the implementation. Tasking a separate division with the charge of integrating investment policies 'in' and 'for' agriculture will be beneficial way forward and provide suitable impetus to capital formation in agriculture.

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3. Climate Change – compounding agricultural risks

Agriculture continues to be fundamentally dependent on the weather and will remain sensitive to short term variations in weather and to seasonal, annual and long-term changes in climate. Climate change is not just the warming of air temperature, but the linked long term alteration in established weather patterns. The change manifests initially in weather disruptions such as un-seasonal rains, winds, floods, droughts, extreme warming or cooling and other incidents. Over the long run, it can cause a drastic shift in the agro-ecology with flora and fauna forced to adjust their life cycles or turn extinct.

There are many examples of how extreme weather events have impacted farmers in the short term, such as when (to mention a few):

- lakhs of poultry died in May and June 2003 in Andhra Pradesh due to heat wave;

- high rainfall in 1998 & 2005 (> 1500 mm) affected kharif and late kharif crop of onion and damaged rabi nursery;

- cold wave in north in 2006 caused frost and ice damage to crops;

- flowering occurred on already bearing mango trees in Bengaluru in February 2010; and

- heat wave causing lower milk yield from cattle and fish mortality in shallow water ponds.

These and many such instances on record, are occurring more frequently and un-predictably, and are seen as indicators of changing atmospherics. When such extremes in weather become more frequent or a norm, then the impact is permanent on agriculture. Scientists all over the world agree that climate change is occurring, and its full impact is yet to be realised.

Impact of Climate change and change management

Agriculture a biologically controlled activity is totally dependent on climate. It is over the millennia that the current global agricultural systems have evolved as shaped by nature. The changes effected to these naturally evolved agricultural systems by science and technology, particularly in the last two centuries have made only marginal and cosmetic changes to the creations of the nature-scientist. In consonance with the climatic parameters inclusive of rainfall, temperature, humidity, etc., agricultural systems & sub-systems have taken shape. The basic principles of natural evolution have created the appropriateness of different agricultural sub-sectors to varying climatic conditions. This could be water guzzling paddy which may be more suited to semi-temperate climates and millets in arid and sub-arid tropics; or template horticulture on the upper reaches of the Himalayas and dryland horticulture in the sub-tropics; or buffalo based dairying in hot and humid climates of the

Deccan Plateau and Sahiwal cow in North India; and so on their forth. Similar patterns would be visible across the continents.

Further, in accordance with the principles of survival of the fittest, the agricultural fauna and flora have also adapted themselves to the geographical situations. Thus has evolved the stable agricultural system of today catering to mankind's basic requirements of food, fodder, industrial raw material etc. It would be more appropriate to say that the agriculture system ever since it originated about 10,000 years ago and transitioned man from hunting to settled stage sowed the seeds of the first civilization. Since then there at best have been only marginal or insignificant changes "in principles" season-bound to the 'in principles' season-bound agricultural practices. The mankind including in India has adopted and shaped his civilization around agriculture.

Agriculture has defined the contours of India's civilization and culture and nurtured the same through centuries. Agriculture has served as the anchor of the majority of India's population dependent as they are on farming for their livelihood. Any basic change in the stability of the agricultural system is bound to impact the farming community in several ways.

With climate change implications resulting in shift in seasons and cropping systems, the life of a farmer, relating to both his profession and cultural life, can be expected to face an unsettled environment. The changes are likely to be substantive, impinging upon the farmers directly, calling upon the need for major re-adjustments. The agricultural practices, which are a natural habit formed not just within a farmer's lifetime but over generations, transferred like inherited traits would be hard to change. The demand for change would be at both mental and operational levels. A farmer's ability to adjust himself to the new environment would be challenged. There would be demand for appropriate skills and resilience. At the simplest level, the farmer would now be required to change the cropping pattern because of shift in season and consequential and new response system in respect of seeds, farm practices, farming equipments & machinery etc. In short, the new challenges would amount to "change management".

The Change Management would involve a certain period of transition from the existing to the new system and it is during this period of transition that the challenges of moving smoothly to a new situation will have to be dealt with by the farmers. The ability of the farmers to manage this fundamental change will depend upon his level of information, knowledge, skill, attitude and above all financial strength. Considering that more 86 per cent of the agricultural households are small and marginal, the fiscal space available to them to cater to the change demands is severely restricted. The levels of literacy and general awareness are also a concern.

Obviously the change management under such circumstances is going to be difficult and would require the Government to provide them both support and counsel. It would, therefore, be necessary that a comprehensive plan and a time bound roadmap are designed and adopted by all government agencies to guide and handhold the farmers through this difficult process of change. The small & marginal farmers, as also the landless agricultural labour would require special attention. This would mean adoption of a package of mitigation and adaptation measures for guiding climate change induced impact on agriculture and farmers.

In this regard, the National Action Plan on Climate Change (NAPCC) comprising, inter alia, eight National Missions in specific areas of Solar Energy, Enhanced Energy Efficiency, Sustainable Habitat, Water, Sustaining the Himalayan Eco-system, Green India, Sustainable Agriculture and Strategic knowledge for Climate Change was released in June 2008.

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4. Farmers’ Welfare

Understanding Welfare

The term ‘welfare’ has a long history and has been a subject of discussions across various disciplines including economics, sociology, political economy, psychology, etc.

The Oxford dictionary defines welfare as:

i. The health, happiness, and fortunes of a person or group.
ii. (a) Statutory procedure or social effort designed to promote the basic physical and material well-being of people in need. (b) North American: Financial support given to those who are unemployed or otherwise in need.

The Merriam Webster dictionary defines welfare as:

i. the state of doing well especially in respect to good fortune, happiness, well-being, or prosperity
ii. (a) aid in the form of money or necessities for those in need; (b) an agency or program through which such aid is distributed

Welfare in terminology can be defined as a minimal level of well-being and provision of social services and support for citizens and other eligible residents who do not possess sufficient current means to satisfy their basic needs. In most developed countries, welfare is mainly provided by the government from tax revenues, and to a lesser extent by NGOs, charities, informal social groups, religious groups, and inter-governmental organisations.

Development also contributes to the welfare of people. For example the building of rural road networks or electrification leads to an improved status of well-being and brings greater opportunities for the region to fare well in their living. In such a case, the development empowers the people to progress and live better.

Ministry of Agriculture & Farmers’ Welfare: The erstwhile Ministry of Agriculture was renamed by the government, appending the phrase “Farmers’ Welfare”. The term ‘welfare’ used here, is translated from the phrase Kalyaan. This is not merely a name change, but indicates the government’s agenda to add focus on farmers, and not on agriculture as a sector alone. In any enterprise or organisation, the human resource is more important that all other resources. In agriculture, farmer is the human resource.

How the notion of kalyaan is interpreted by development agencies, is important to how they drive the associated programmes. Would it be appropriate to link kalyaan only to social services? Or is this more about economic welfare, associated with long term well-being, to be achieved by empowering farmers with the right knowledge, tools and facilitation. Has the concept of kalyaan been lost in translation? It is important to understand ‘welfare’ from the perspective of empowerment and not limit the interpretation in relation to gratuitous patronage or daan. Farmers too have repeatedly expressed they seek opportunity to progress in economic terms, and not a dependence in perpetuity. This is also evidenced in recent demands by farmers to find optimal value at markets, and support in optimising their business opportunity.

Indicators / measures of farmers' welfare

In the light of the above discussions, a farmer's welfare can be defined / calculated in terms of:

- both absolute and relative average income;
- availability and accessibility to social security system – education, health, etc.;
- facilitating the farmer in moving up Maslow's need hierarchy beyond social security.

Some of the measures suggested are:

- average monthly income and consumption expenditure and the resultant saving / surplus;
- income spread amongst agricultural households belonging to different size classes of land holding;
- comparative monthly income of agricultural households vis-à-vis other professional classes;
- relative monthly income of agricultural households vis-à-vis the national average of the whole population;
- percentage of farmers below poverty line.

Some additional measures of welfare suggested for adoption are:

- average size of indebtedness and access to institutional credit;
- average amount of investments in creating productive assets;
- average rate of literacy; and
- state of health of the family [life expectancy at birth, Infant Mortality Rate (IMR), Material Mortality Rate (MMR)]

Measuring farmers' income and farmers' welfare – standardised methodology and interval:

As of now, there is no fixed interval estimates of farmers' income. In the absence of a standardised approach, reliance for evaluating the state of farmers' income is sample survey based estimates of NSSO (2002-03 and 2012-13 agricultural years); and estimates by researchers. These are not only not enough, but also do not meet the requirement of monitoring the change in farmers' income in the light of the vision of doubling farmers' income by 2022. It is, therefore, suggested that:

- A comprehensive parametric based scale be developed to measure farmers' income and welfare (economic and social parameters be incorporated).

- The interval of measure should be annual, based on a sample survey; and five yearly, based on universal survey.

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5. Planning and Review – Institutional Arrangement

As per constitutional arrangements, agriculture is a state subject. Hence, both production and marketing are primarily viewed as the responsibilities of a state machinery. The world has always recognised the importance of a vast market. Hence the globalisation the world experiences. India as a nation with its enviable geographical expanse, facilitative agro-climatic basket and elephantine consumer base should not fail to recognise the advantage of pan-India production and marketing design. After all, there always is an inter-play of several vectors across the states, as also across the nations influencing overall growth and development.

This entails a continuum of planning, implementation, review and monitoring between the Gram Panchayat and Krishi Bhawan, via the District and State headquarters. This is however not to suggest, that agriculture should be moved out from the state jurisdiction. It is only to emphasise that dismantling of state-bound mind-set in production planning and boundaries in marketing would help the farmers take a more rational decision vis-à-vis both production plans and market access. Against this understanding, following institutional systems are suggested – one led by the political leadership, another by the bureaucratic executive and the third as a domain authority.

i. Three-tier system for planning, reviewing and monitoring.
ii. Four-tier arrangement for convergence of resources, coordination of efforts and synergy of execution.
iii. Omnibus agricultural regulatory authority for dispute resolution of all issues.

Three – tier system

The Department of Agriculture, Cooperation and Farmers' Welfare (DAC&FW) has already advised the state governments vide its letter, dated, 22.3.3017 to put in place the following systems at state and district levels and has issued Guidelines to this effect. The main objectives to be achieved by these Committees are as follows:

i. Focus on increasing the net income from each unit of farm by reducing the cost of cultivation / production, increasing per unit yield and higher market return on the farmers' produce.
ii. Make efforts to offer security to farmers against unpredictable nature of agriculture through comprehensive crop insurance, unified insurance package (UIP), speedy & efficient delivery of relief entitlements and the like.
iii. Enhance access to institutional credit, both by increasing the volume of credit and also by better targeting.
iv. Supplement the farmers' income, particularly during off-season times by creating an enabling environment for generating alternate off- farm activities.

v. Build farmers' resilience and prepare them to negotiate unpredictable nature of farm activities and low level of income by coverage under various welfare schemes of the Government.

vi. Check every probability of farmer-suicide by working to remove indigence and vulnerability among the farming community. vii. Improve Governance with a view to achieving efficiency and transparency in delivery of agricultural services.

Four–tier arrangement for effective implementation

Following and in harmony with the decisions of the three-tier institutional mechanism as discussed in the preceding section, a robust system for ensuring effective coordination in implementation is necessary at all appropriate levels. The following system is suggested:

National level: Agricultural Development and Farmers Welfare Group

The system of domain-dedicated "Group of Secretaries (GoS)" introduced over the last 3 years has proved to be very effective in breaking thought barriers and mainstreaming annual strategic interventions.

Agricultural Dispute Resolution Authority

The government may consider an authority for agricultural dispute resolution. This proposed Authority would serve as a fast track redressal mechanism for matters such as disagreements relating to crop insurance, land leasing, contract farming, and other implementation issues. This will offer an alternative to disputes in various areas that effect the farmers' economic activities. The Authority could be omnibus and quasi-judicial, and hence do away with the need for individual authorities for agricultural matters like contract farming, land lease, etc.

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6. Grassroots Level Participation

As Strong as the Weakest

As put concisely by Leibig in his "Law of the Minimum", the strength of a chain is the strength of its weakest link. It holds good in governance, administration and management relating to agriculture sector too. Take the case of average yields across various crops and sectors in India. The high global ranking of India in terms of volumes of production is more a function of area or number (e.g. of bovines). However in terms of productivity, there is so much to catch up.

The average gap between the FLD (farm level demonstration) and farmer field level yields varies from 28 to 63 per cent depending upon the crop. If one measures the farm yield against the research plot claim, the scene only worsens. This illustrates, that notwithstanding the high yield potential of a variety at the research station, most of it does not manifest at the farmer's field level on account of several reasons, and therefore in this case, it is the farm and farmer who constitute the weakest link. In the final analysis, the strength / potential of the 'variety' is equivalent to that of the farm and farmer.

The delivery pipeline should therefore focus on identifying various constraints and challenges, which if surmounted will enhance the capacity of the weakest link and improve the efficiency of the delivery system. The challenge as identified and elaborated in the preceding volumes can be categorised under: technology, manpower, material, finance, knowledge and human resource. The most sensitive and critical of all these is the 'end-user' the farmer. Hence, intense involvement of the farmer in the process of decision making and implementation can enhance the capacity of the weakest link.

In the opinion of the DFI Committee, the farmer also needs to be reoriented and capacitated in respect of the following:

- Awareness, knowledge and skill
- Openness to new ideas and technology
- Perception of agriculture as an enterprise – transition from subsistence (production dominant) to commercial (market-centric) practice
- Willingness to join interest groups like FPO, value chain platform, FLG, cluster etc.

Co-opting the Farmers

It is a common complaint of the farming community, that they are not adequately represented in making decisions that concern their interests. At the macro-level, it is presumed that the elected representatives of the people (of whom farmers are a dominant sub-section) represent the farmers' interests. There is no denying, that they do, as is manifested in several legislations at parliamentary and state assembly levels.

Thanks to 73rd Constitutional Amendment, the decentralised democracy has taken decision making process closer to the farmers through the system of Panchayat Raj Institutions (PRIs). In fact, these PRIs at the district (Zilla Parishad), taluk / block (Taluk / Panchayat Samiti) and village (Gram Panchayat) levels are closely and intensely engaged in agriculture related decision making, more specifically with reference to implementation.

There are also state / national level Boards, Cooperatives and Corporations, that have places reserved for those representing interests of the farmers.

Then there are Gram Sabhas, Watershed Committees, Forest Management Committees, Milk Societies, PACSs (Primary Agriculture Cooperative Societies), APMCs (Agricultural Produce Marketing Committees), WAUs (Water User Associations) and the like which are further decentralised institutions, that operate right at the cutting edge operation & maintenance. There are innumerable other non-formal or more correctly voluntary-in-nature based grass-root level bodies. Some such examples are SHGs (Self Help Groups), JLGs (Joint Liability Groups), Commodity Interest Groups (CIGs), FPOs (Farmer Producer Organisations – both cooperatives and companies), etc.

Not to forget are the pressure groups of farmers. These are mostly the farmers associations with varying degree of ability to influence decision making at government level, besides creating an opinion in the society.

Despite these plethoras of formal and informal institutions, organisations and platforms, a large majority of the farmers feel that they are not well represented in decision making and that their interests are not well protected. The challenge therefore lies in evolving systems that will facilitate wider and more genuine participation from all type of farmers.

Gram Panchayats as delivery institutions

Gram Panchayats (GPs) are the lowest level, decentralised and integrated developmental institutions headed by peoples' representatives, and supported by field level bureaucracy. Hence, they constitute the most appropriate centres for dovetailing developmental and welfare programmes. Since the 73rd Constitutional Amendment, these centres are getting consolidated, capable of shouldering multifarious responsibilities. Rural development activities, including wage employment initiatives under MGNREGA are channelled through

GPs. Agriculture sector is the basic and most expansive development intervention that relates to the majority of the rural society.

It is, therefore, both appropriate and important to make GPs responsible for agricultural development encompassing planning and execution. The village level action plan should be prepared at GP level and integrated into Block Action Plan (BAP).

Gram Panchayats as Centres of welfare

Farmers' welfare deserves special emphasis. In relation to this, the care of both land owing / cultivating farmers and landless agricultural workers should become the mandate of Gram Panchayats (GPs).

Direct participation of farmers

With increasing awareness and negotiation skills, the farmers, and the youth in particular are eager to participate in the decision making process. Gram Sabhas provide a good platform for intense deliberations and decentralised decision making.

Deeper penetration of IT network and mobile usage (both smart & basic), make it possible for virtual interaction. With deployment of portals, IVRs, skype and video-conferencing facilities, the intensity of farmers' participation can be deepened. It is important to take advantage of technology, that bears the capacity to neutralise hierarchy, break down barriers, jump decision making stages and create a friendlier & hassle free and flat & horizontal partnership.

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7. Investment Pattern in Irrigated and Rainfed States

Investment is important for holistic growth and development of any economic activity. In agriculture too, it is key to sustained output growth. There has been a significant increase in investment in Indian agriculture (when both public and private investments are considered together) in the post-reform period, compared to that in the pre-reform period. In the 1990s, the time when Indian economy embarked upon the phase of liberalisation, the growth of public investments was however not very encouraging. There was subsequently a change in the trend in the 2000s. Since 2003, the government has been injecting funds into the agricultural sector at an accelerated rate, which to an extent defies the notion of 'neglect of agriculture' built up during the 1990s (Bathla, 2014).

Investment at state level assumes importance in the context of weaving a policy, that promotes policy balanced regional development. India is home to diverse agro-ecological systems. However, agriculture in the country is still largely rainfed and vulnerable to vagaries of monsoon. But few regions/states in the country like Punjab, Haryana and western Uttar Pradesh, as also other states with large river systems have been able to bring a large proportion of their cropped area under assured irrigation, and these for the purpose of analysis have been grouped under Irrigated States and other categories are defined by the status of irrigation available for agriculture

An Examination of Capital Investments

Public investment

The nature and magnitude of public investments in agriculture are generally explained by the priority of the government towards the sector. The public sector investment is key to creation of irrigation, roads and power infrastructure. The share of public GCFA (gross capital formation in agriculture) has always been lower than that of private GCFA, at nearly one-fourth of the total investment in agriculture.

Private investment

The private investment comprises investments by household sector as well as the corporate sector. So far, the major share of investment is accounted for by the household sector and the score in case of corporate sector as a percentage of private sector investments is as low as 2-3. While public sector investment has been a primary contributor to capital formation in agriculture through creating irrigation, roads and power infrastructure, the role of private sector is important too and its role is gaining recognition in moving the agriculture to next stage of development.

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8. India - Subsidies in Agriculture

Subsidies are amongst the most powerful instruments for influencing or balancing the growth rate of production and trade in various sectors and regions. Subsidies also play an important role in correcting the existing inequalities in the society, when used to protect interests of the weaker sections. In India, agriculture is of prime importance since around half of the labour force is still engaged in this sector. Despite several measures since independence, average rural incomes are still far behind average urban incomes. The input support through subsidy in fertilizer, credit, electricity and output support via MSP bassed procurement operations constitute some important interventions. These subsidies have been consistently deployed by the government to protect the interests of farmers.

During the last three decades in particular, subsidies provided by Government of India have shot up substantively from Rs 12,158 crore in the year 1990-91 to Rs 2,43,811 crore in 2015-16. The percentage share of fertilizer subsidies in the total basket of subsidies increased from 36.41 in 1990-91 to 51.4 in 2000-01, and declined thereafter to the level of 29.9 in 2015-16. This decline in percentage could be on account of brining phosphorous (P) and potassium (K) under NBS (Nutrient Based Subsidy), and higher procurement cost arising from substantive increase in MSP for various notified crops including wheat, paddy & pulses. Further, with adoption of National Food Security Act, PDS (Public Distribution System) has become more universal entailing higher quantum of food subsidy.

The ratio of poverty is higher in rural areas, where agriculture continues to be the dominant economic activity, notwithstanding some structural changes in the rural economy over the last about a decade.

India is among one of the largest producers and consumers of fertilizers in the world. Initially fertilizer subsidy was introduced to ensure its availability to farmers at an affordable price, and enable adequate returns on investments.

Food subsidies in India

The subsidy obligations of Government of India on account of foodgrains have increased significantly over the last two decades from Rs. 6,066 crore in 1996-97 to about Rs. 1,22,676 crore in 2014-15, an increase of over 20 times. Since 1996-97, food subsidy as a percentage of total subsidy grew from 39 per cent to 57 per cent in 2003-04, and thereafter declined to 47 per cent in 2014-15 (Table 12.9). The government's foodgrain policy is mainly carried out by the Food Corporation of India (FCI). It is the FCI or its selected state government agencies, who acquire paddy and wheat from farmers at the notified minimum support price (MSP). The Government of India utilizes the procured wheat and rice under Targeted Public Distribution System (TPDS) and other welfare schemes and for maintaining the buffer stock of foodgrains so as to ensure food security. The quantum of wheat and rice meant for TPDS is issued to the states and union territories at a highly subsidized rate. The differential between the procured and issued price is met by the central government. While this is a huge financial obligation, it integrates the loop between procurement and disposal of the commodities. While the consumers benefit from subsidized food, the farmers benefit from assured market at MSP.

However, several studies have shown, that this system has benefited only a few states, and further the relatively larger farmers within these states, with higher marketable surplus ratios. It is also no gain saying, that it has benefited only 2 crops – wheat & paddy.

Centripetal influence on subsidies

The subsidy related experience over the last 50 years since the introduction of green revolution in the country shows, that there is a tendency of various subsidies to crowd around a certain point, influenced by centripetal force. Take the case of green revolution, that majorly banked on paddy and wheat for driving the food security vision of India. The crowding has happened in the following way:

- High Yielding Varieties (HYVs) were introduced for paddy and wheat.

- Both were irrigated crops, and HYVs needed intensive use of inputs like water & fertilizers for them to express phenotypically in-synch with their innate genetics potential.

- Each of these inputs – seed, fertilizer and water needed to be incentivized by offering price concession to increase their adoption.

- Further, adoption of the new package of technologies had to be incentivized by offering a minimum support price (MSP), so that pre-seasonal notifications served as a price signal to the farmers, and they could be influenced to grow paddy and wheat.

- Since the agricultural markets were not efficient enough to discover remunerative prices on the paddy and wheat output, they had to be offered price support in the form of procurements at MSP by the Food Corporation of India (FCI).

The above chain comprising several links came to be built on heavy subsidies at each stage. It turned out to be a typical case of acquiring a cat to keep off the rat, which then necessitated acquisition of a cow to produce milk for the cat reared at home and so onion an endless way.

New challenge from surpluses

The current times in the history of India's agriculture is faced by a challenge of another nature, which emanates from a situation of surpluses, and ironically disfavouring the farmers from realising remunerative prices. This is however not an insurmountable problem. Several market reforms rolled out by the government, supplemented by the proposed broadbased procurement operations will come to benefit the farmers.

Over the years, government sponsored subsidies to farmers in terms of fertilizers, irrigation, electricity and procurement-subsidy system have witnessed an annual increase. Of the total planned revenue expenditure for agriculture, significant part is spent on subsidies leaving a very small amount earmarked for capital investment in agriculture. As a result, agriculture sector in India seems to be more dependent on input subsidies relative to other large emerging economies. The need is to priortise capital investments over subsidies, reserving the latter to the truly needy among the farmers. Further, subsidy transfer can be efficiently targeted by adopting Aadhaar linked Direct Benefit Transfer (DBT). Savings achieved by this, should however be retained for agriculture sector and added to the yearly normal budgetary allocations for enhancing capital investments for basic infrastructure like irrigation, power, roads, communication, post-harvest agri-logistics, markets and the like.

What is further worth appreciation vis-à-vis the present situation of surpluses, is the window that is now available to make wholesome changes to the policy support including Agri-R&D and broadbase agricultural transformation, besides making it income-centric. Towards this directional change, the substantive size of subsidy that is annually offered can be restructured and apportioned for right investments and for the targeted farmers, who need support of subsidy.

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9. Inflation Management

Food Inflation

Food inflation trends in India over the past few decades show that diverse commodities have been the reason for food inflation in different years, and that no specific commodity can be held accountable for high inflation. Studies show that eggs, milk, meat, fish, vegetables and cereals were the main influencers vis-a-vis the most recent food inflation.

Vegetables and fruits revealed a much higher degree of intra-year volatility; high-weight commodities in the national consumption basket also showed very high inflation rates; and the contribution of pulses and edible oils remained low in terms of inflation. Shekhar et. al. (2016) established that both supply and demand factors are the reasons for inflation.

Prices of commodities such as cereals and edible oils seem to be driven by supply-side factors such as wage rates, level of production and minimum support prices, whereas in case of pulses, the effects of both supply- and demand-side factors appear almost equal. The prices of eggs, meat, fish, milk, and fruits and vegetables appear to be driven mainly by demand-side factors.

Several studies like those of Anand et al. (2016), Meenakshi (2016) and Shekhar et. al. (2016) have also highlighted the importance of these factors in shaping India's inflation dynamics and determining the conduct of monetary policy. Sonna et al (2014) provides substantial evidence on the importance of demand forces. The study shows that rising real rural incomes have had the major impact on food inflation while cost-push factors have a relatively smaller impact. Gokarn, S. (2012), in his comprehensive analysis of India's key food price issues for more than fifty years summarises, that rise in food prices is because of stagnation in food supply and food inflation cannot be contained until and unless food supply is regularised.

The Other Side of Food Inflation: Input Cost

In the recent past, there has been a significant increase in agricultural cost of production. To analyse the extent to which increase in cost of production in agriculture has contributed to food price inflation, agricultural input price indices have been used, which consisted of major farm inputs like fertilisers, pesticides, electricity, high speed diesel, light speed diesel oil, fodder, cattle feed, tractor, agricultural machinery & implements and lubricants. Within the category of agricultural inputs, light diesel oil recorded the highest inflation, followed by high-speed diesel and lubricants. Another traditional explanation for rising food prices has been the input supply-side shocks related to climatic conditions, either because of droughts or floods. Often, it is observed that the sudden slump in food supply associated with climatic conditions has led to food price inflation. (RBI, 2014).

Balancing Food Inflation and Guarding Farmers' Interest

The rising food inflation has been regulated by adopting different measures over the years. Some of these include subsidies on food and fertilisers, imports of food, and prevention of hoarding of farm produce. Though they did succeed in stabilising prices, such crisis management practices have been able to provide only short-lived respite, failing to check a continuous upward trend of food prices since 2007.

Over-emphasis on containing food inflation is good for the consumers, but bad for the farmerproducers. By causing stagnation in prices of food items, food production is rendered unattractive to the farmers. This approach will make food prices less remunerative; and discourage investments in agriculture, putting further stress on supply-side in the long run triggering inflationary pressure as a sequel. An effective strategy to keep food inflation at optimal level, while also benefiting the farmers from higher returns consists of enhancing per ha. yield (through more efficient production system) and an efficient agricultural marketing system (through market integration and a robust agri-logistics), that will ensure, a higher share of the farmer in the consumers' rupee. Merely increasing the prices in the market may not ensure better returns to farmers, as it may benefit only the intermediaries. From the farmers' income perspective, higher prices in the market constitute only a necessary condition, but not a sufficient condition. Capturing a higher share of the final value is therefore of more relevance.

Several other steps are needed to increase farmers' share in the consumer's price. The need is to lower the transaction costs. The farmer pays for transportation over long distances for his produce, before actually knowing the value at which his produce would be sold. The journey from farm gate to final consumer involves multiple levels of conveyance, labour expenses, commissions of agents and a market fee & cess, roughly adding to nearly one-fifth cost to food prices. There is need for large outlays to set up climate-controlled infrastructure to enhance the shelf life of farm produce. The public private partnership (PPP) could play a significant role in boosting the investment and adding value to the infrastructure. There is also need to add value to farm produce by facilitating food processing on a much larger scale, as food-processing industries can enhance both shelf life and add value to the products. However, some regulations like the Essential Commodities Act (ECA), which imposes strict restrictions on stock limits and curbs movements, creates uncertainty, dis-incentivising long-term investments. This calls for reforms and liberalisation, and assume importance in the overall strategy for doubling enhancing farmers income.

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10. Mobilising Farmers

Cooperatives are present in most of the countries and in almost all the sectors, including agriculture, food, finance, health care, marketing, insurance & credit. A cooperative is an autonomous association of persons, united voluntarily to meet their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise.

Cooperatives have inherent advantages, for addressing issues of poverty alleviation, food security and employment generation, considered to have immense potential to deliver goods and services in areas where both the public and private sectors have failed. Since its formal launch in 1904 in India, the Indian Cooperative Movement has played very important role in the Indian economy, especially in the development of the agriculture and rural domains combining the strengths of both public and private sectors. In particular, the small and marginal farmers and weaker sections have benefited from cooperatives.

Agriculture sector, which still employs 48 per cent of the total workforce in India and contributes around 15.5 percent to the country's GDP (2016-17), needs sturdy cooperatives so as to overcome many of the difficulties faced by the farmers, especially in the context that 86 per cent of the farmers belong to small and marginal category. Farmers in India usually buy their inputs at retail price and sell their produce at wholesale prices, thus loosing at both stages. Organisations built on the concept of collectives (cooperatives and FPOs), could play key role in numerous areas like input purchase farm advisory, value addition and branding, storage facilities, soil-water-seed testing, purchase or hiring of customize farm machinery sale of output.

Need for Cooperatives in Agriculture

Lack of sufficient numbers significantly reduces the bargaining power of small and marginal farmers both in case of input procurement as well as sale of produce. Small and marginal farmers require agricultural inputs in small quantities, which they procure from local traders at a considerably higher price than the wholesale rate. Most of the times, inferior quality of these inputs further aggravates the problem. Often for small and marginal farmers transporting small quantities of produce to urban markets is not a feasible option, and they end up selling their produce (most often perishable produces) to local traders at lower prices than normal. Lack of techniques for access to credit and insurance services and vulnerability to several forms of risks (climate change, pests and other risks) complicate the scenario for small and marginal farmers in India. Several of these concerns have given rise to the notion of a cooperative so as to ensure low costs of inputs, opportunities for value-addition and processing, collectively increasing the numbers so as to enhance bargaining power in case of marketing, (Agarwal, 2010), and access to formal credit (Braverman et al., 1991).

Successful Cooperatives in India

In the first few decades after independence, the sector played a pivotal role in the economy, especially in respect of primary sector production. Maharashtra, for example, has been home to some successful cooperative movements in agriculture, with the strong emergence of sugarcane farming and sugar production cooperatives, as well as in consolidation of cooperative credit banking system. The dairy cooperative is another success story in India. The Anand model for cooperative milk marketing in Gujarat launched in the year 1946, with its well-recognized Amul brand, provided later the blueprint for replicating its success elsewhere under the National Dairy Development Board program, contributing to the success of Operation Flood.

In case of fertilizer production and distribution, the Indian Farmers Fertilizer Cooperative (IFFCO) controls over 35 per cent of the market. In the production of sugar, the cooperative share of the market is 58 per cent, while in the marketing and distribution of cotton it is 60 per cent. Cooperative sector accounts for 55 per cent of the production in the hand-woven textiles sector, whereas cooperative marketing and distribution channels account for 50 per cent of the edible oil market in India. Dairy cooperatives in India, operating under the leadership of the National Dairy Development Board (NDDB), collectively, are the largest producers of milk in the world.

Notwithstanding the significant gains made by the cooperative movement, the sector has of late shown signs of slowing down with several issues emerging. Unfortunately, the notable successes have remained limited to some apex groups, while most of grass-root cooperatives continue to remain fragile and continue to depend on outside agencies for their survival.

Linking Cooperatives with Farmer Producer Organisations (FPOs)

Cooperatives being traditional in structure, lack linkages with buyers, input suppliers, etc., who are vital actors across the larger supply chain. This undermines long term sustainability of cooperatives. Thus came a new form of collectives called Farmer Producer Organisations (FPOs) to address the challenges faced by the small and marginal farmers, particularly those to do with enhanced access to investments, technological advancements, and efficient inputs and markets (Hellin et al., 2009). These collective efforts, evidently offer means for small and marginal farmers to contribute in the otherwise imperfect markets of the developing countries (De Janvry et al., 1991).

The basic purpose envisioned for the FPOs is to collectivise the small farmers for backward linkage for inputs like seeds, fertilizers, credit, insurance, knowledge and extension services;

and forward linkages such as collective marketing, processing, and market-led agriculture production (Mondal, 2010). While cooperatives entail benefits to farmers via state intervention, FPOs are perceived to empower farmers through collective bargaining along with imparting an entrepreneurial quality to farming, which otherwise is practised as a subsistence, particularly by the small and marginal farmers.

Heralded as contributors to livelihood enhancement through provision of substantial gains beyond what is possible within the traditional farming context, FPOs that function as farmer producer companies, can leverage on the strengths of cooperatives to engage with the government on reforms in agriculture.

Government of India has initiated several measures towards this. The Small Farmers Agribusiness Consortium (SFAC) mandated by Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt. of India, supports the state governments in the formation of Farmer Producer Organisations (FPOs). Besides providing initial grant, it also provides venture capital assistance.

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Agriculture

Chapter 10

Short Answers

CSM-05: Compiled by Prof. Ashok Vishandass

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This chapter contains:

- Minor Forest Produce
- Support Tools
- Operationalising DFI Strategy
- Post-production Activities and Infrastructure
- Strategy and Approach
- Potential and Challenges
- Targeting the Outcome
- Crop Diversification and Post-production Management
- Analysis of Changes on Input Costs and Crop Income

Contents

1. Minor Forest Produce

Tribal Society and Cultivation Practices

As per 2011 Census, the Tribal community population of the country accounts for 8 per cent. While the tribal population is spread across the nation's geography, the concentrated pockets mostly pan across the Central Indian, Eastern and North-Eastern States. In a number of eastern states like Jharkhand, Odisha and Chhattisgarh the tribal population goes up to as high as 23 per cent, and within these states there are districts with tribal community as the majority population. The social and economic life of these communities is woven around the forests; dwell as they amidst the forests.

In majority of such areas, not only is agricultural land not settled under individual ownership and continues as community owned land, the practice of agriculture is also not sustainable. Since agriculturally fertile land as the ratio of the total land in their dwelling region is less, the tribal society practices shifting cultivation along the slopes of hillocks which goes by different names like jhum, podu, etc. The practice in essence is slash and burn, where under the vegetation is put to fire during summers and the land is readied for raising millets and pulses. After raising the crops in successive years for about 3-4 seasons, they move onto the next hillock, to let the cultivated space rejuvenate. The cycle of such cultivation has gradually dwindled on account of growing population and restrictions brought under the Forest Act, making cultivation unsustainable.

The tribal communities gather different kinds of 'minor forest produces' (MFP) from the forest areas and this constitutes a major source of income.

Changing Forest Laws

Over the civilizational times, the traditional forest was a mixed forest that yielded a range of non-timber forest products (NTFP). These encompassed tree/bush borne oilseeds, fruits, flowers, roots, shoots, leaves, bark and herbs. They were the source of food and medicine, apart from constituting the ecology.

The rights of forest were entirely usufructs rights, which meant that there was no claim over the land. The Forest Act, 1927, changed the nature of relationship between the tribal society and the forests as the latter came to be notified as 'out of bound' for the tribal communities. With this piece of law, the tribal communities who had been living in symphony with forests for ages came to be rendered as trespassers. While this position continued for many decades, including after independence, the provisions of the Panchayats (Extension to Scheduled Areas) Act, 1996, commonly known as 'PESA' made a favourable breakthrough in favour of the tribals. However, while the Act conferred the ownership of 'minor forest produces (MFP)', it did not define the term leaving a critical lacuna. In addition, no mechanism was provided for framing of rules at state level, so that a clear definition could emerge based on the local circumstances.

Another major deficiency of this Act was that the ownership of MFP was conferred on the Gram Sabha and not the NTFP gatherers. A favourable change in this regard was came to be achieved through the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006. This Act commonly known as Forest Rights Act was brought into correct the deficiencies of PESA. That, this Act confers the tribal-gatherers a legal ownership over the MFP is a positive measure in the relationship between the tribal society and the forests. With proper implementation of the provisions of this Act, the rights of tribals society can be well protected.

Recommendations

(i) It is necessary to recognize non-timber forest products (NTFPs) as a source of income at par with agriculture in case of the tribal communities and facilitate them to improve the practices of gathering MFPs. This requires proper training and orientation, use of appropriate mechanization process and harvesting practices.

(ii) It would help to promote the self-help groups (SHGs) of the gatherers and provide them with a well-appointed place (drying yard, storage, primary processing support etc.) so that the small lots can be aggregated and traded more efficiently.

(iii) The trading of MFPs can also be integrated with online agriculture trade platforms like e-NAM by developing needed standards, rates etc. and developing assaying labs. The provision for trading in MFP including online trading can become part of the State Marketing Act APLM or if the states feel necessary they may enact a separate Act on similar lines as that of Agricultural Marketing. The Act can be called as Minor Forest Produce Marketing (Promotion and Facilitation) Act. The Union Ministry of Tribal Welfare can develop and share Model Act and Rules with the states for adoption.

(iv) Comprehensive development of the NTFPs may be taken up and funds available under various ongoing schemes like MGNREGA, Tribal sub-plans etc. can be used.

(v) MFP value-system supported by integrated value-chain and supply-chain management may be put in place.

(vi) Now that the government is promoting agro-forestry and bamboo under the National Bamboo Mission outside the forest areas, even these products can become part of the MFP value-system.

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2. Support Tools

Measuring of Farmers' Income

The progress of agriculture so far has been monitored more in terms of area coverage, production and productivity. These are no adequate mechanisms existing, if income changes are to be measured. There is no system of direct measurement of farmers' income at fixed intervals. This would be a sine-qua-non, considering that the strategy for doubling farmers' income is time bound. Even if there is no such time-bound target, it would help in annual measurement of farmers' income (farm + non-farm income) to evaluate the progress and make necessary interventions. This would be a very effective instrument in transitioning agriculture as an agri-business, besides serving as one of the important measures of farmers' welfare.

MIS Based Dashboard - Effective and Qualitative Implementation

There is surfeit of data collected at various hierarchical and horizontal levels by different divisions & organisations within the department / ministry, as also across the departments / ministries. Unfortunately, the data structure is not uniform. The architecture of Applications, Portals, Websites and other data / information collection points is not standardised. The result is isolated databases that cannot talk to one another. Required, and possible today, is an effective tool for real time evaluation and monitoring of the performance vis-a-vis the laid out targets. Inter-operable and open source architecture will help in seamless integration through cross DB intelligence and use the power of big data analytics and its interpretation for visualising patterns & trends and delineating the messages.

An appropriately designed Management Information System (MIS), operated via dashboard, will serve as a command and control system. When installed on need to know basis, at various hierarchies – Gram Panchayat - Block/Taluk – District – State - National levels, it will provide for seamless sharing of data and information, and interpreted in a harmonised language and format. It is then possible to work for a shared vision, common mission and for universally accepted objectives & targets.

Rationalisation of Organisations

In response to specific needs arising from time to time, several organisations have come up over the years. They may be within an individual department or ministry or outside. These organisations are generally in the nature of autonomous bodies, attached offices, corporations, boards and directorates.

There are overlaps in mandates across these, leading to not just duplication, but at times also leads to cross-purpose work or differing messaging. This is in addition to the avoidable establishment costs on men and material. Within the Ministry of Agriculture itself, there are several such organisations under each of its three (3) departments (DAC&FW, DAHD&F and DARE/ICAR).

Reforms and Ranking – Ease of Doing Agri-business

As well recognised by now, the reforms and liberalization story of India's economy that begins in 1991 has left out agriculture sector to a large sector. Nevertheless, there were some good initiatives taken as well, in agricultural marketing (Model APMC Act, 2003 and Model APMC Rules) and agricultural trade (removal of stock limits under control orders in 2006). However, the agriculture sector still needs to adopt comprehensive reforms with a view to ease:

(i) Pooling of land (ii) Mobilisation of farmers (iii) Promoting marketing efficiency (iv) Developing logistics infrastructure for market connectivity (v) Making available inputs that are low in cost and high in quality

Ranking of States

Competition can bring in a healthy spirit of achieving excellence and performing better than others. The "Ease of Doing Business" ranking of the World Bank at global level has demonstrated, that nations tend to compete and perform better. Within the country too, the "State of States" ranking by India Today magazine has introduced an element of healthy competition. The Prime Minister's Civil Services Awards by evaluating the performance of Districts in respect of Government of India's flagship schemes has also proved, that healthy competition can trigger change.

The NITI Aayog has identified five states and 200 districts that are lagging in terms of development, based on five domains including agriculture. In order to enhance the overall economic growth of the country on a sustainable basis, the NITI Aayog recommends special focus on these identified states and districts. The NITI Aayog is aiming at live competition for all the stakeholders based on measureable achievements in respect of the five domains. This is initiative is also with the rationale that competition will bring out the best among all the stakeholders and lead them into better performance than hitherto.

On similar lines, it is suggested that inter-se ranking of all states and UTs may be taken up on an annual basis on "Ease of Doing Agri-business". A quantifiable, parameter based evaluation of states and UTs vis-à-vis the reforms done during the year to effect simplification of procedures, transparency, objectivity, etc. may be adopted. Such recognition itself is expected to position the states appropriately and help them attract investments. However, care must be taken to build an evaluation scale that is agreeable to all parties and is conducted by a third party in a credible manner.

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3. Operationalising DFI Strategy

Setting a New Course for Agriculture

The Prime Minister of India has, in sharing a new vision for the farmers of the country, laid out a challenge, to double farmers' income by the time the country celebrates its 75th year of Independence in 2022. This challenge, though on the face of it, targets primarily the farmers; it in reality touches all Indians. For everyone, including the consumers, are affected by the status of agriculture and financial health of the farmers. The target is achievable with a good strategy, well-designed programmes, adequate resources and efficient governance framework for implementation.

New interpretations have been tabled by this Committee by redefining various concepts that were in vogue for long. Many of the policies & programmes that can support the DFI strategy are in place, and will serve the purpose better with appropriate changes. And, there is need for new ones too. It is in this context, that certain recommendations have been made to restructure the existing ones, including the governance mechanism, and also adopt new ones as needed. It is also important, that the available resources are prioritised and the strategy does allow to suitably improve upon the capital and resource use efficiency, as efforts are made to channel additional resources by creating a stake for multiple agencies.

The vision requires a grass root level shift in the attitude towards agriculture, in all citizens of the country, including among farmers and in the government agencies at different levels of hierarchy. The DFI Committee in its discussions felt that there is an urgent need to bring about a mind-set change amongst all stakeholders. What logically follows is the usefulness of creating a dedicated 'Centre-Point'. Otherwise, with diffused responsibility, the historical agenda that seeks to bring about a farmers' income revolution, can get lost. Sometimes, it may be a situation of missing the wood for the tree. The DFI Committee through its multistakeholder consultations, intra-committee deliberations and dissection of the complex agricultural value system was drawn to a logical conclusion, that the DFI strategy implies "Farmers' Income Revolution".

The agriculture sector needs an overhaul, and not just a transformation, if farmers' income is to be enhanced substantively and consistently. This makes a case for a change in the narrative that the time has come to transcend from 'Green Revolution' to 'Income Revolution', to give meaning to a comprehensive change. Green revolution, with its major emphasis on production attempts, is only a partial treatment of the agricultural sector. Income revolution impresses upon production through productivity, sustainability, marketability and an orientation shift towards farmers' income as outcome.

Empowered Body

However, the officers down the line beginning with Secretary of the Department/Ministry are extremely occupied with multiple and administrative tasks. They may hence be challenged, by both time and the mind space needed to create the implementation framework vis-a-vis the recommendations. An 'Empowered Body' can build such a framework and offer the needed support system to the principle stakeholders, namely, the DAC&FW and other Departments/ Ministries. As an illustration, one of the DFI recommendations is to popularise the post-harvest interest subvention based loans. This will call for development of 'Guidelines' and an 'Operational Strategy'. The Empowered Body should be able to meet this requirement. Similarly, Model Rules following the adoption of Model APLM Act, 2017 and Model Contract Farming & Services Act, 2018 will need to be developed. The DFI Report contains several such recommendations that need close attention, but may be difficult for the Ministries / Departments to allot the required time. It is the Empowered Body that can own such additional responsibilities and provide the much needed 'reform and restructuring support'.

Role and responsibility of the Empowered Body

The proposed Body housed in the Ministry of Agriculture and Farmers' Welfare will require coordinating directly with Secretaries of various miniseries and departments, centre and state. The following roles & responsibilities are suggested to be assigned:

i. Develop necessary Acts, Rules and Regulations for the concerned ministry/department, so as to assist states and the centre to fast track the required restructuring and governance reforms.
ii. Draft executive orders and guidelines for the concerned ministry/department, that will help ease specific bottlenecks in implementation of programs and in executing the support planned by the government.
iii. Help undertake necessary capacity building and advocacy, to build a greater understanding among general public, polity, academia and farmers, on the related set of changes they need to incorporate in their approach towards agriculture.
iv. Coordinate between and among ministries/departments to help bring about a convergence in the financial resources deployed, for greater resource use efficiency; and synergy of efforts. This can be initiated for selected activities and regions, at first instance.
v. Prepare the schedule and monitor the data on income status of farmers on an annual basis.
vi. Suggest interventions needed for course correction in policy or implementation, which need may arise, as the agricultural system undergoes transformation.

The DFI Committee views this 'Empowered Body', by whatever name it goes, as the final necessary resource centre. It would be expected to study the recommendations and the logic behind them, and provide a comprehensive support to the implementing ministries and departments.

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4. Post-production Activities and Infrastructure

A few decades ago, our cities adjoined lush fertile farmlands; whose farmers would harvest their produce in morning hours, and aggregators would rush the produce to the local wholesale centres. The normal practice for fresh food supply (to reach our homes), was quite simple and a matter of routine. By the time the consumer visited to buy his/her daily basket, the local grocer or street vendor was ready with that day's fresh supply. This was an effective food supply system, even though highly fragmented, which ensured that each morning's harvest was at the tables well within 24 hours. There were those awkward vagaries of weather and unbalanced supply, but the consumer too was a friendly and understanding stakeholder

Urbanisation has ensured that farmlands are distanced very many kilometres away, entry points into our cities are becoming bottlenecks and transit time to reach markets is ever increasing. No more can the harvest reach the consumer within its natural life cycle. What now reaches the consumers' homes, was harvested a previous couple of days or more ago! This extended 'in-transit' time is compounded by the perpetually growing demand, wherefore the increase in handling volume adds to the delays. In case of perishable produce, the marketable life cycle is under pressure, and food quality is degraded rapidly without recourse to enablers such as coldchain. Lack of cold-chain systems force farmers to monetise their produce at first instance by selling into food processing units, inefficient wholesale markets; and these sales are the only opportunity, low down in the value chain system, and do not empower the farmers.

In case of cereals and grains, the post-production life cycle of the produce is naturally lengthier. The foodgrains are procured and stored in godowns and warehouses, for the near future requirements. These requirements can be consumption demand or as assessed for national security purposes. The market tends to rely only on cues from ongoing government interventions, by way of Minimum Support Price (MSP) and procurement targets of the government, or Minimum Export Price (MEP) to arrive at the associated market value.

Farmer's Market Channels

Post-production, the farmers monetise their produce and, across agricultural produce segments, having a series of market avenues as their selling points. These can be itemised to the following, each being a destination of the first stage evacuation, where the primary monetisation of farmers' produce occurs:

a. Near-farm mandis, where farmers deliver produce for local buyers – for primary assembly and wholesale transaction.

b. Near-farm 'Farmers markets', where farmers can sell to consumers – retail transaction.

c. Government procurement of foodgrains – a controlled and limited market avenue.

d. Near-farm processing units where farmers can deliver produce as raw material for new product creation – contracted or wholesale transaction.

e. Near-farm aggregation points, such as milk-chillers and pack-houses, for extending onwards market connectivity – very few developed for horticultural crops.

Farmers perforce sell their produce at first points of evacuation, to local intermediaries (at-farm or near-farm), constrained and limited in their selling range, and thereby have no further direct role in the overall value system. Lack of logistics connectivity with farmer groups, effectively means that the markets are getting farther away from the reach of most villages, and therefore, the small and medium farmers find it technically and economically unviable to directly access various markets. Currently, intermediaries as aggregators step in to complete the logistics link for farmers, at times even upto the first level assembly markets (local mandi).

Infrastructure status

The primary development focus for agricultural post-production infrastructure, has been in the form of warehousing and cold stores, for holding inventory for extended durations. The infrastructure needed to connect with markets after the storage phase may not have found strategically linked policy support.

Inefficiencies in the Infrastructure

Over the years, a number of organisations and institutions have been established with a mandate to develop one or more areas of agricultural marketing such as procurement, storage and warehousing, credit, co-operative marketing, exports, food processing, agricultural prices, marketing training, research and extension. In infrastructure terms, special focus was given to creating storage capacities both dry and refrigerated as well as market yards.

The essential activity of physically transporting the farm produce to buyers' destination was largely left to individual commercial interests, which has then developed in a fragmented fashion. Neither was attention paid to provision of farm-gate or village level centres, in the hands of the farming community, to aggregate and prepare the produce for subsequent postproduction market linkage.

The private sector participation in agribusiness trade also developed, given the opportunities from government's initiatives as well as the near perpetuity of demand for food and agri-based products. However, the various control orders to regulate and manage the market, did not allow more holistic and larger private enterprise to develop infrastructure for all aspects of agricultural produce in the country.

Monetisation of Agricultural Produce

Monetisation is traditionally described as the conversion of an object into a medium of exchange, such as metal into coins. In economic terms, monetisation refers to converting a nonrevenue generating asset – investment, asset, event, debt, etc. – into a source of revenue. From the perspective of this Doubling Farmers' Income Report (DFI), agricultural produce is a unit of value, which via a liquidity event (sale transaction) is converted into currency. Farmers' produce undergoes the process of monetisation, via various market channels (explained in section 2.1). The total value monetised is also dependent on the extent of food loss mitigated and the magnitude of value captured from every grain, drop and ounce produced. The process is expected to be transparent, equitable and assign the most appropriate price to the unit of value (produce). This is enabled better, by gaining access to a choice in markets, balancing supply with demand and by appropriate governance mechanisms.

The purpose of monetisation in the context of income approach to agriculture is to capture the best possible value of the produce for the farmer, once harvested. While market is a place where an appropriate value is discovered on the produce offered for sale, the share of the farmer in the consumer's rupee is predicated upon the market structure. It would, therefore, be necessary to not only maximise the price discovery through an efficient marketing system, but also enable the farmer to benefit from as large a share as possible in the end consumer's rupee. This depends upon dis-intermediation or when intermediaries share in margins is proportionate to the service offered in the marketing chain.

The related issue is the extent to which the volume of produce harvested is monetised. Higher the food loss that occurs between the farm gate and market place, lower is the quantum of produce monetised. This is a function of agri-logistics including harvest practices, storage, handling, transportation, etc.

In sum, monetisation of farmer's produce is dependent upon several factors, inclusive of agrilogistics, marketing system, marketing efficiency etc. It must be appreciated that marketing efficiency, though very important, is only one of the many factors influencing monetisation efficiency of the farmer's produce.

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5. Value System in Agriculture

"Agri -Value Chain" System

There is increasing emphasis on the development of efficient agricultural value chain system in India. A "Value Chain" is strictly understood as a process view of the set of operations and procedures, internal and in control of an individual business unit. The term was conceived to represent the linear operations that create value for a business unit, and to provide decision supporting analysis of the primary activities and secondary support in a firm. A value chain analysis allows the individual firm to identify unit cost of operations and make systemic changes to reduce internal inefficiencies and wasteful expenditure. These interventions are desired so that the business entity can accumulate more value. The analysis helps to refine its procedures, so as to improve its competitiveness and efficiency. The value chain does not define the business model, but details the internal operations of an individual entity.

A value chain is appropriately constructed at the level of individual business unit. Each such unit has a set of activities to create and sell its product or service. The desired outcome in value comes from the core operations, and in managing raw materials, manpower, credit, equipment and the administration. Each activity is expected to add value to the business, more than the sum of costs of all activities. Value chain is not necessarily about value-added products, but about optimising value for a business.

However, market linkage may not develop in a linear fashion, and multiple firms (each an individual value chain) function to integrate into a sectoral or industry level value system. The industry value system is a model where multi-stakeholder activities integrate, to produce goods and in delivery of the final product to end-consumer. This integration is commonly known as the supply chain (the supply chain is not a value chain). As a number of value chain entities collaborate, each firm intercedes to vertically integrate their activities into the external supply chain, to target a market. The ensuing value based supply system, is also at times misread as an incremental build-up of costs, across the activities from first source to end-market.

In a value system, the cost of a set of linked activities in the supply chain, is expected to capture value equal to, or greater than the sum of costs incurred. For e.g., the aggregation and transport activities are expected to carry the produce to a higher paying market. Balancing supply with demand is another key factor in discovering value. Therefore, the value finally realised will not always be equal to a value evaluated at source or where surplus exists. If the systemic costs incurred, detract from final value realised, then the industry level value system is considered inefficient. The system depends on how effectively each entity optimises its own functions (reduces costs and losses) in supplying the target market. An entity can also choose to internalise external activities, and thereby expand its scope in the larger supply chain.

The supply chain can be product agnostic, and relates to the agricultural produce marketing system. For example, a cultivator's value chain includes the primary functions of input procurement (inbound logistics), the sowing, cultivation and on-field care of the crop (production), the harvesting and carrying of produce to a local market (outbound logistics) and the primary sales (marketing). The support activities in this value chain are the acquiring and managing of tools, equipment and manpower involved in the primary activity (deploying farm labour, weeding, pumps, tractor, harvester, etc.). The farmer can shift crops, can transact with another firm, the aggregator, transporter, wholesaler or processor. The transporter, wholesaler, or processer are separate value chains, if not under umbrella of a single capital or management, each constantly tweaking their internal competences and procedures to compete with others in their trade. They however, form a part of the larger value system that directs the value first produced, to point of final consumption.

A supply-chain is the integration of the individual activities undertaken by multiple value chains, each an actor in the supply chain, with the purpose to manage the flow of the materials and goods, starting from raw inputs to supply of final value at last mile. In a supply chain, a series of enterprises systemically integrate their operations. Though the actors can be transient; together the value chain actors coalesce into the overall supply chain to ensure that systemwide, value based outcomes are effected. The business scope of a firm, is directly linked to how well it integrates into the market linked system. A single business entity rarely internalises the entire supply chain, ranging from inputs, production to final end-consumer retailing, though many may undertake supply chain management. Simply put, 'value chain' is the operations of an individual business entity; 'supply chain' refers to the business model.

The term 'Agri-Value Chain', therefore, refers to the value based system at a combined level, to the overall system-wide correlation between value chains of the producer, market channels, retailer and consumer (each a value chain segment). Hence, the agri-value chain represents the agricultural supply chain in the country. The industry or sector level value system, also includes secondary activities such as research, development, front line demo, extension work and all others support that addresses the core activity of producing and marketing the produce.

Expanding a farmer group's operations to the immediate post-production aggregation and handling activities helps capture greater value and has happened on occasion. Even the transport link can be integrated into operations by farmer groups and/or by involving the rural youth as driver entrepreneurs, to assure that more value is captured at the village level.

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6. Strategy and Approach

Market Linked Strategy

Agriculture economy of India is undergoing a natural progression of development, in terms of trade practices, business opportunities and availability of technologies, enabled by policy support. These dynamics offer opportunities and as well throw challenges for the agri-business systems and trade. A shift in food preference of the consumers, towards high nutritional value produce, characteristic of the rise in disposable income, is also resulting in a shift in trading preferences both in value and practices. To fully harness these opportunities, farmers today have the option to undertake crop diversification, vertically integrate as a value chain component of existing processors, horizontally integrate with market through appropriate aggregation of the produce and associated adoption of technology for the wider supply chain.

The required systemic and policy changes, however, need calibration to empower the farmers to convert these opportunities into income growth, ensuring an inclusive approach, as in the country there is a predominance of small and marginal farmers (>86 per cent). This calls for evolving an enabling environment and infrastructure that will endow the farmers with the tools to overcome the inherent constraints of the sector, for increasing their incomes from agriculture as well from activities allied thereto.

To double the famers' income by 2022-23, the strategies will need to bring key focus on production enhancement, cost reduction through smart nutrient management, low input farming system approach, non-farm income enhancement through diversification and skilling, stabilising of income and risk management. However, these components which are mostly productioncentric need to be complemented with ease in market access with efficient post-production logistics, as the first step to market arbitrage. All efforts towards enhancing the production and productivity, along with diversification, require to be linked with market demand, with prime emphasis on ensuring that the complete quantity produced has physical access to all possible selling avenues and can get monetised. The priority has to be to increase the market reach of farmers to enhance their selling volumes, while all other incremental revisions to optimise upon the inputs would remain as ongoing interventions.

There are two key linkages that need to be strengthened between farmers and market in the postproduction stage of farming. These are the physical logistics linkage with markets and information flow from markets, and this calls for significant attention on issues of access to infrastructure, technology, the institutional arrangements; and support services for capacity building, identification & development of markets.

Inverse Approach, from Fork-to-Farm

The concept of seamless farm-to-fork connectivity is normally presented when relating to food supply systems. However, to function in agri-business mode, there is need to adapt to demand triggered supply chains. The farm-to-fork connectivity tends to infer, that farmers will directly interact with the consumer. The concept stems from a mind-set that promotes a push model from farms to market end, from a time when the market could absorb all that was supplied. However, the price and the quantities absorbed at markets are directly related, and require understanding market demand. All businesses dealing with consumer products follow a demand linked methodology when accessing market channels. While in case of certain crop types like fibres, potatoes for chips, grapes for wines, etc. the demand is consolidated in the hands of the agro-processing unit, in case of fresh consumables, such consolidation of demand is limited.

This has special import in case of India, which is the world's largest concentration of vegetarians, making the fresh market important. A reverse approach, to link demand with agriculture is needed for the crop types where farmers depend on income from marketing of fresh whole produce. Effectively, there is need to work backwards from demand, providing information that can intelligently direct the physical flow of foods to linked markets.

Adopting an inverse, FORK-to-FARM strategy, to guide future developments, is needed. A well designed strategy will look at capturing new markets so that subsequent ramping up of production will be monetised optimally. The immediate concern is to connect the produce with as many markets as possible and the business model requires linking the source with target markets, and planning a delivery or settlement mechanism after farm-gate procurement.

Access and Tactic

To double farmers' income, the first priority is to ensure that the entire production off the farms finds a market to get monetised. To double income it is essential to double the selling volume of the farmers. This is critical when a large percentage of produce is lost after production, detracting from income, which results in the input costs being loaded on the remaining saleable volume. In the shorter term, value can be recovered by targeting sectors, where food loss incurred is high and demand goes unfulfilled.

The primary concern for India today, is to bring its immense farm-gate production to gainful and effective end use - to reach the hands of consumers, regularly and efficiently. Every kilogram wasted due to poor post-harvest handling & logistics capabilities is also a loss multiplied in terms of resource wasted and in greenhouse gas emissions. Any loss on the supply side has an immediate ramification on farmers' income and inflation.

The ability to physically connect the material produced with markets is inhibited for individual farmers due to low handling quantity per farmer. This inhibiting factor is due to the generational fragmentation of land holding, leading to small lots of marketable surplus. All access to markets is made via some mode of transport and a critical mass or viable quantity is required for this purpose. Where the farmers are able to collectively pool their produce (milk is an example), onwards market linkage is easily undertaken to the benefit of the farmers. Except in case of milk and large plantation crops, there is little organised collection for onwards market linkage evident, though hundreds of market yards have been developed.

Categorising Agri-produce by Holding Life

Strengthening of the country's agri-logistics for doubling the farmers' income and improving the post-production productivity is a necessary priority. Agriculture post-harvest logistics includes a) first stage aggregation; b) first mile transport; and depending on type of produce, c) transitory or long term storage; d) long haul or wholesale transportation (rail, road, water, air); e) distribution hub; f) last mile transport; and g) intermediary processing or manufacturing for certain produce types.

A modern supply chain needs to function within the holding life, or usable life of the produce. This is a primary factor when planning the post-production phase of logistical activities to cover the remaining life cycle of the farm harvest. Broad categories are long and short life cycles, as explained below. The holding life indicates the "time spread" in hand for sales.

Role of Agro-processing

The agro-processer is an intermediary in the farm-to-consumersupply system and communicates demand from end consumers to farms, and constitutes another mode of revenue for the farmer. In case of non-food crops, processors are the oldest example of agriculture allied business enterprises, which converted farm produce into usable consumer goods. Agro-industries like textile, leather and medicine are apt examples and have been a driving force for agriculture worldwide. Modern technology allows even the traditionally unwanted by-product from food produce, to be brought into commercial use as raw material for use in building materials, polymers, cosmetics, adhesives, dyes, fuels, detergents, bio-energy, etc.

Agro-processing activity is an important source of income for farmers as it converts the primary agricultural produce into usable items for food, feed, leather, fibre, fuel or industrial raw material. Regular developments in agro-processing technologies have led to the progress of agro-allied industrialists and they have become a primary market for the farmer. Of these, food processing specifically deals with manufacture of food products and given industry status in the country.

Globally, there are varying interpretations of food processing and some countries include the activities that only prepare and package the fresh produce for marketing purpose. However, these activities do not convert the farm produce into another product, but only precondition the fresh produce for travel to market.

Role of Railways in Agri-logistics

Once agricultural produce has been aggregated and prepared for onwards transit, the next step is to evacuate the pre-conditioned produce to distant markets, thereby bridging the supply side with demand, through the provision of transport over multi-modes, i.e. roadways, railways, waterways and/or airways. The aspect of sub-continental distances to consumption centres, indicate that Railways can play an important role in triggering an agricultural marketing revolution, wherein railheads can co-locate or be linked to the modern produce collection centres, encourage a number of floating stock of containers (refrigerated) dedicated for food cargo, and be the transport backbone to the National Agricultural Market.

Railways not only speed up the logistics connectivity, which is important in case of perishables, but also can cover longer distances, which is key to achieving improved value realisation for farmers. As such, railways will play an important role in the marketing and delivery mechanism.

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7. Potential and Challenges

Farmers' see agricultural markets as an important avenue to monetise their produce. Essentially, for the farmers, the possible ways to monetise their produce are the local mandi, the wholesaler, agro-industry and local consumers. Any inability to do so, leaves the farmers to sell off their produce to agents or intermediaries between these points of sales, which comes at a cost. The future growth of farmers, is therefore, limited to the growth of such intermediaries, rather than their own capability to connect with larger markets. From the farmers' perspective, the ability to easily connect with buyers and safely execute an exchange with market players, is a priority.

Without expanding the market range of farmers, their income growth is directly linked to growth of local buyers (growth in population plus shift in consumption patterns). To capture a larger share of consumption, the frontiers of their market need to expand into the national market and further into exports. For this, agri-logistics capabilities of both farmers, as well as aggregators and facilitators, have to be suitably developed. Agri-logistics plays an enabling role, by aiding direct connectivity with the larger market, backwards to the farmers.

There has been much focus on creating farmer markets, as an opportunity for farmers to directly sell to local consumers. Farmers' markets are operating in different States in the name of Apnamandis in Punjab & Haryana; Rythu Bazaars in Andhra Pradesh and Telangana; Uzhavar Sandhai in Tamil Nadu, Shetkari Bazaarsin Maharashtra; and Raitha Santhe in Karnataka. These are typically located at the rural-urban fringe and benefit both farmers and local consumers.

These farmer bazaars can be compared with the local dairy shed, where consumers could visit the milking shed and buy their daily needs directly from the milk producer. Being limited in their geography, these bazaars do not change the selling radius of a farmer. As a result, the customer footfall remains limited to local consumers, and the capacity of local population to absorb higher production is constrained. Like the local doodh-wala, farmers' bazaars are essentially a stop gap measure, to provide individual enterprising farmers an independent and nearby avenue to monetise their produce. They do get a higher share of the consumers' spend, but any agenda to tap into other markets is not fulfilled.

Near-farm jobs

Pack-houses provide a permanent near-farm facility to initiate an organised flow of produce to markets, for the post-production supply chain. Pack-houses require transport connectivity to feed the terminal markets which in turn distribute the food to consumers. Pack-houses, in effect function as small scale logistics centres at village level, connecting agriculture with urban centres. They are opportunities for growth and job creation.

Increase in selling volumes

Higher selling volumes mean higher income and impetus for greater productivity on farm. Logistics connectivity allows more produce to securely reach more markets. The idea behind scientific post-harvest management is to enhance post-production monetisation of the produce.

The obvious corollary is that after primary post-harvest care, the value must be transported to end-destination. Increase in production quantity has to be met with expansion of the market frontiers, so that all that is produced has a chance to get monetised.

Agri-logistics when limited to warehousing or storage alone, only builds buffers to buy time for a delayed transaction. This may be suitable for foodgrains and allied goods, as the commodity has long holding life and can be actively traded in futures linked to demand from the processing industry or end consumers. However, the organised users who take final delivery, stay limited and volumetric throughputs can remain more or less flat.

In case of perishables, the time gained in holding life by using cold chain, is better used for covering distances and capture a larger market footprint. Expanding the geographical reach of producer from growing area across the unified market, will help to bridge the demand supply gap and increase the selling volume. Improved post-production logistics will also transform the dynamics of the unified National Agricultural Market network.

In all cases, post-production activities that lend towards expanding the market reach of the farmers, will increase the selling footprint of the produce and bring greater organisation to the flow of produce from farms to markets. Keeping in mind food loss reports and other inputs, effective market linkage provides opportunity to reduce produce loss and convert that share into revenue. Besides converting food loss into earnings, an increase in selling volume is also expected to build confidence in the farmer to accordingly produce more and adopt more productive practices for cultivation.

Financial assistance provided by Government

The Government has various subsidy based schemes for strengthening marketing, cold-chain, warehousing and processing infrastructure facilities in the country. The broad outline of some of the major schemes that subsidise the creation of post-production infrastructure are:

i. Schemes of Ministry of Food Processing Industries (MoFPI)
ii. Schemes of Department of Animal Husbandry, Dairying & Fisheries (DAHDF)
iii. Mission for Integrated Development of Horticulture (MIDH – DAC&FW)
iv. Rashtriya Krishi Vikas Yojna (RKVY – DAC&FW)
v. Integrated Scheme for Agriculture Marketing (ISAM – DAC&FW)
vi. Programmes supported by Food Corporation of India (FCI – DFPD)

vii. Agricultural and Processed Food Products Export Development Authority (APEDA - MoCI)

viii. National Cooperative Development Corporation (NCDC – DAC&FW)

Challenges to Post-production Activities

In the agriculture allied domain, the infrastructure development efforts were focussed largely on building storage capacity, basis a favoured hypothesis of cross seasonal carry through of produce. This has resulted in the development of single commodity bulk storage and warehousing (both ambient storage and cold storage).

All infrastructure need assessments were done with the harvest quantity as the starting point, assigning a predetermined percentage of the production as surplus for storing. The assessment presumed that all agricultural commodities can be stored endlessly, for trading or against collateral based credit, like other hardy commodities. However, the large basket of agricultural produce, requires a highly differentiated approach to the infrastructure development, keeping market access, storable life and the marketable life cycle of the produce in context.

A mind-set change is required to move away from mere storage of excess production, and adoption of a system-wide value chain approach, to ensure that all inventory can be brought to final consumption, in quality and in time. For the immediate benefit of farmers, the priority is to connect with demand, and not delaying or deferring the consumer as a preferred option, where practicable. Agriculture is not fully served by procuring and storage of produce, but by directing the harvest to consumption. A holistic approach to logistics requirements is needed.

The infrastructure system – the aggregation, transportation, storage and distribution – requires to integrate their operational capacities so as to serve as a conduit to the market and not function in isolation. This also necessitates that the capacities and number of infrastructure created, complement the overall volume being handled. For e.g., having a large capacity in warehouses, without access to an equivalent handling capacity in transportation, only results in a selfinflicted bottleneck to the desired market connectivity. This delayed or failed linkage is the cause of unnecessary inefficiencies, including price instability for consumer. Many a time lack of collaboration and market linkage has let good inventory to turn into wasteful discard.

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8. Targeting the Outcome

To enhance farm incomes, an important component of farmers' income, there is the related need to enhance the selling volume of the farmers, and not merely the growth in farm output. This desired increase in selling volume can be achieved by enabling that a large part of the currently high percentage of the losses, especially in high value produce, reaches markets and is monetised; besides opening up the country as one market with eased access. Metrics for evaluating impact of development efforts need to be rationalised and made outcome oriented. The annual reports by development agencies normally list the financial and physical numbers to demonstrate achievements. There is need to observe outcome and output measures to adopt result oriented targets. These measures would typically be the throughput achieved vs capacity created; food loss vs production; revenue vs inputs costs; and new market capture.

Throughput achievement

Agri-logistics infrastructure is created in case of agri-allied activities for post-production market linkage. The physical target of implementing agencies should include the volumetric throughput of farm produce, at least for first 3 years of operation. Throughput measure is a multiple of two factors - the holding capacity created, and the number of rotations or cycles achieved on this capacity in a year. Using this measure as a target, will ensure that the development activities do not cease at just creation of infrastructure, but also encompass monitoring and support in the initial years of operation, making the development more outcome based.

Food Loss reduction

Normally, production statistics are put forth during and after harvest season. These production numbers undergo a series of iterations, until the final production by district or state is declared. The declared production figures are used to assess the GDP/GVA contribution of farmers. The quantum of production that cannot be monetised, due to lack of post-harvest market linkage, is a loss that must be considered as recoverable value to farmers and the country.

An independent and regular sampling survey schedule to assess physical loss of food produced along various activity stages should be put in place. The key stages in post-production would be the quantum aggregated and rejected at farm-gate (local market yard, pack-house, or private aggregator); quantity discarded at wholesale market (processor, warehouse and wholesale mandi); and quantum lost in fields. Reducing such physical loss will permit more saleable volumes in the value chain system, allowing for greater monetisation of the produce.

Revenue generated

There has been no comprehensive and regionally differentiated assessment of the revenue generated by farmer from various available avenues. An ongoing third party assessment of the revenue by farmer from sale of own cultivation (to wholesaler, processor, trader/aggregator), from near-farm jobs, from non-farm jobs, from migratory jobs may be initiated. The development activities can accordingly be adjusted and relevant course corrections initiated to achieve the overall strategy of doubling farmers' income.

Market expansion and access

In order to give the farmers better access to markets, a number of reform measures have been undertaken by Government of India in recent years. Government of India has formulated the Model Agricultural Produce and Livestock Marketing (Promotion & Facilitation) Act, 2017, and States should adopt its provisions to evolve a common market for the marketing of agricultural produce across the state and country. A central Agricultural Trade Act is also being contemplated, which will more pronouncedly provide a legal footing to create a barrier free access for trade across the country and enable all the pre-requisites for a truly unified national agricultural market. The constitutionality of such a central Act will however need to be evaluated.

The focus needs to be on integrating the small holders, constituting 85 per cent of Indian agriculture, into an organised mechanism that will facilitate national level access and increase the selling range of the farmers. An effective linkage, however, is also stymied by small lots of marketable surplus, dispersed & disjointed centres of production, resource constraints, high price risk, etc.

Infrastructure Development Targets

Creating infrastructure is not a sufficient condition; the creation must be outcome oriented and they must come into productive use. Besides the existing methodology of monitoring annual physical and financial achievements, the following 'outcome matrix' is recommended for use by various development agencies and departments.

In case of long holding commodities, the throughput could also refer to the unit's inventoryturn-ratio. Generally, having larger stocks over extended periods would reflect as a signal about demand variation, and be used as an indicator for the next cropping cycle.

Lowered throughput achievement in relation to the size created would be used as a signal to rationalise the expenditure on infrastructure creation and divert efforts to the missing links.

To double farmers' income, changes need to be implemented to measure and monitor the outcome from developmental efforts. The target setting should primarily be to affirm that more of the farm production reaches all possible market avenues and gets monetised.

Besides having a direct impact on increasing the earnings, this will also lend impetus to become more productive of the land, which will further add to farmers' incomes.

To double farmers' income, changes need to be implemented to measure and monitor the outcome from developmental efforts. The target setting should primarily be to affirm that more of the farm production reaches all possible market avenues and gets monetised. Besides having a direct impact on increasing the earnings, this will also lend impetus to become more productive of the land, which will further add to farmers' incomes.

Development interventions must keep their focus on making sure that every grain, every ounce and every drop of produce finds opportunity to realise value, and not limited in markets by place, time and form.

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9. Crop Diversification and Post-production Management

Backdrop

Food security concerns, have hitherto, brought specific focus on raising production and productivity, mainly of cereals. The critical aspect of ensuring nutrition security for Indian population, in general, and how it correlates to enhance the net income of farmer households, in particular, are two aspects that have not received equal attention by policymakers. However, during the last decade, researchers have begun to pay considerable attention to the following:

- Augmenting the growth of agriculture through the diversification towards high-value crops (HVC), particularly horticulture (mainly fruits and vegetables);and
- Assessing whether the small holders have benefited from the diversification towards HVC

These studies have contributed significantly to our understanding of how diversification has led to the growth of the agriculture sector in the wake of the shifting consumption pattern of Indian households towards high value products like fruits, vegetables, milk, fish, and meat.

During the discussion on doubling of farmers' income, it has been argued that expanding the area under HVC will help increase farm income, as it has been found that expanding HVC by one hectare at the expense of staple crops, yields an additional "gross returns up to Rs. 1,01,608 per hectare"47. However, it is important to determine the extent to which expanding the area under HVC would help in increasing the net income.

Another important issue to be considered pertains to a high degree of harvest and post-harvest losses, particularly in fruits and vegetables, which account for significant economic losses.48 The existing marketing system of agricultural produce is also reportedly fragmented and entails high transaction costs. Since there is a wide variation in the estimates of harvest and postharvest losses given by different agencies, this issue needs to be examined from the perspective of enhancing farmers' income. The other associated issues that need to be addressed include the role of private traders in regulated markets, and evolution of an appropriate marketing system to increase farmers' income and reduce market fragmentation.

It is also pertinent to examine the level of gains that can flow to farmers through improved post-harvest management and development of the agro-processing industry. An efficient postharvest management, comprising aggregation, preparatory activities and pre-conditioning, refrigerated transportation and other cold-chain/agri-logistics, not only reduces the proportion of agricultural produce, especially perishables that are otherwise discarded, but also aids in expanding the size of the market.

Harvest and Post-Harvest Losses

This section focuses mainly on:

- The harvest and Post-Harvest Losses (PHL) of horticultural produce that is of a perishable nature; and

- The relative roles of different agencies to which the farmer sells his horticultural produce.

Special attention is paid to the losses incurred on certain products that are deemed as sensitive products because of their mass consumption, such as onion, potato and tomato. These products are considered sensitive in the sense that even a mild rise in their prices adversely affects their consumption by a large section of the population, particularly the poor.

A large number of studies have been conducted on the measurement of harvest and post-harvest losses in different regions of the world, covering a wide variety of agricultural crops and seasons. A meta-analysis of PHL has been done by Kitinoja and Kader (2015), offering a critical review of various studies. These authors argue that the estimates of PHL from these studies cannot be easily compared as the research has been done "without much explanation of what is being measured, when or how". Even the studies on PHL in India (say, on horticulture) are not easily comparable due to the varying coverage and concepts of PHL used by different authors.

Role of the Private Trader in Perishables

It is interesting to note that despite the APMC being in operation, the largest single agency at the national level to which the farmers sell their horticulture produce is the private trader. The mandi (regulated market) is, in fact, second in order of importance as a purchaser of the farmers' produce.

Nature and Composition of the Indian Food Processing Industry (FPI)

It is important to understand the nature of the food processing industry for at least three reasons: (i) employment and income generation opportunities in the non-farm sector increase if a greater proportion of the agricultural produce is processed; (ii) the relatively low skilled labour gets employment in view of the significant role played by the unregistered sector or informal sector in food processing, although this may not provide a decent (high wage) level of employment; and (iii) since an increasing Total Factor Productivity (TFP) in the food processing industry is an indication of the sustainable linkage between agriculture and industry, a sustained growth of the former would further enhance the prospects of raising non-farm income. However, the extent to which it would benefit the farmer households directly is difficult to quantify.

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10. Analysis of Changes on Input Costs and Crop Income

The agricultural sector had registered impressive growth during the 1980s, which was followed by a slump in growth during the 1990s and early 2000s. Various studies have shown that the total factor productivity (TFP) growth in major crops decelerated in the 1990s. Despite the revival of growth since the mid-2000s, concerns have been expressed by researchers and policy planners about various issues including the decline in crop incomes; the fact that agriculture is turning out to be non-remunerative; and causes economic distress among farmers.

With the improvement in production, India's position has changed from being a net importer of agricultural products to an exporter of certain commodities. At the farm household level, the Green Revolution technology has helped improve the livelihood pattern, nutrition and education of children (Hazell and Ramasamy, 1991; Foster and Rosenzweig, 1996; Baker and Jewitt, 2007).

According to the findings of the Government of India's National Sample Survey conducted in 2003, 27 per cent of the farmers did not find farming profitable, and 40 per cent said that if they were given the choice to pursue some other occupation, they would quit. There were also concerns about slowdown in the yield of major crops. Despite the occurrence of some degree of diversification from field crops to horticulture, the amount of income generated from field crops still matters for improving the income of farmers' households.

Estimation of Crop Income

For the estimation of agricultural income, secondary data were compiled from the National Accounts Statistics and the Cost of Cultivation of Principal Crops in India. While data from the National Accounts Statistics are used to analyse the changes in agricultural income at the macro level, the cost of cultivation surveys are used for the state level analysis. The 'cost of cultivation' surveys are conducted annually by the Ministry of Agriculture to collect farm level data on inputs, output and prices.

The Commission for Agricultural Costs and Prices (CACP) mainly uses the cost of cultivation data for fixing crop-specific minimum support prices. Eight types of cost concepts are used for working out the alternative incomes from crop production based on the cost of cultivation survey data. Among these costs, Cost A2 is the paid out cost and is widely used for analytical purposes to track changes in the welfare of farmers. Cost A2 includes all actual expenses in cash and kind incurred by cultivators, and the rent paid for leased-in land. However, the CACP uses the total (full) cost given in the form of Cost C2 for fixing of the minimum support price. The Cost C2 includes the rental value of owned land and interest on fixed capital. These cost components have been estimated through the method of imputation, which is considered to be defective as it does not reflect the actual prevalent rates. Nevertheless, Cost C2 is also used to analyse the changes in crop income.

Changes in Agricultural Income at the National Level

India's National Accounts Statistics provides the agricultural GDP, which is estimated in terms of gross value added by deducting the value of consumption of intermediate inputs from the value of output for the sector. This also includes gross value added from the operation of government irrigation system. Figure 5.1 shows the trend in annual growth in gross value added and consumer price index for agricultural labourers (CPIAL). The gross value added indicates agricultural income, while the CPIAL shows the price that rural persons pay for the purchase of consumer products. It is evident that the percentage change in CPIAL was higher than the agricultural income during most of the years under study. The years which were characterised by high agricultural income over the consumer price index, were affected by drought and hence the higher base value has resulted in higher growth. Agricultural growth showed a declining trend continuously from the mid-1990s to the early 2000s. There was a revival in growth from 2005-06, albeit with wide fluctuations, but it declined sharply again during recent years. The trend in movement of agricultural income clearly indicates that the purchasing power of farmers has remained low and has, in fact, been worsening during recent years.

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