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## **VAJIRAM & RAVI**

### **REJUVENATION OF AGRICULTURE THROUGH RESEARCH**

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Given the importance of agriculture in Indian economy, the Government has initiated several policy reforms to increase the income of farmers. In July 2019, a **high-powered committee of Chief Ministers to “rejuvenate Indian agriculture”** was constituted. This committee has highlighted the importance of R&D in agriculture sector.

#### **Steps Taken To Promote R&D**

- The Government has allocated **2.83 lakh crore rupees** in the budget for the year 2020-21 for agriculture and allied activities, irrigation and rural development, which is the highest budget allocation to date.
- The foundation stone of **Agricultural Research Institute at Hazari Bagh, Jharkhand** was laid in 2015.
- The **Indian Council of Agricultural Research (ICAR)** was established to promote agricultural research in the country.
- There are, at present, 102 research institutes and 71 agricultural universities affiliated to ICAR, across the country.
- ICAR has also earned recognition internationally in teaching **subjects like agronomy and agricultural engineering**. This organisation has established a **vast network of 718 Krishi Vigyan Kendras (KVKs)** for extension and spread of its valuable agricultural research benefits.

It was the outcome of providing latest technology of agriculture to the farmers that as compared to the year 1950-51, today our country has registered growth of 5.6 times more in food grain production, 10.5 times more in the horticulture sector.

India's total food grain production has increased to 285 million tonnes in 2018-19

#### **Research Related to Crop Varieties**

- A total of **220 crop varieties** have been notified and released for commercial cultivation in the year 2019-20. It includes 101 varieties that are climate-friendly, while 15 are multi-stress tolerant varieties. **Twenty bio-fortified varieties** of various crops, including rice, maize, have also been developed.
- ICAR and the Department of Agricultural Cooperation have **set up 150 seed hubs** in different parts of the country and provided seeds of improved varieties to the farmers.
- India still imports edible oil. This problem must be resolved through '**zero edible oil import**'. Taking action in this direction, ICAR has conducted more than 50 thousand national level cluster frontline demonstrations on oilseed crops in the last one year.
- **Pusa Basmati**, developed by ICAR, is the **world's longest kernel of paddy**. It is the most sought-after rice variety in the world.
- The **productivity of sugarcane variety-CO- 0238**, developed by ICAR's Sugarcane Breeding Institute, Coimbatore, is **76.5 tonnes per hectare**, which is 14 tonnes per hectare more than the popular varieties.
- The **disease-resistant varieties** of tomato- '**Arka Rakshak**' and '**Arka Samrat**' have been developed to ensure bumper production.

#### **Livestock Development Research**

- During the period 2014 - 2019, 40 new animal species have been registered and notified.
- An active surveillance system has also been developed to **make India free from Foot and Mouth (FMD) disease by 2024**. For this, a temperature tolerant vaccine is being developed. A total of 43 diagnostic kits were developed.

### Horticulture Sector

- Today our country **ranks first in horticultural production**. The report of the committee constituted in 2018 to take measures for doubling the income of farmers, estimated that the volume of horticultural production is expected to reach 451 million tonnes by the year 2022-23.
- The ICAR has notified a total of 133 new varieties of horticultural crops during 2019-20 and released them for commercial cultivation.

### Fisheries Sector

- Apart from meeting domestic demand, the country has also earned \$7 billion in foreign exchange through fish exports. An online information system has been developed to provide information on various aspects of fish species of India origin.

### Opportunities

- The agricultural sector **demonstrated an extraordinary resilience to withstand economic shocks** even during the Corona crisis.
- A report by the World Trade Centre says that **India could register among the top five exporters in the world** in terms of exports of agricultural commodities by focusing on farming and practical measures for the betterment of farmers.
- **India is ranked eighth in 2019, with annual agricultural exports of \$39 billion.**

### Steps Taken

- To limit the use of chemical fertilisers in the agricultural sector, the Government is promoting **organic farming**. The Ministry of Agriculture provides **financial assistance to the tune of 50 thousand rupees per hectare** to the farmers associated with organic farming under **Paramparagat Krishi Vikas Yojana (PKVY)**.
- The government is also **promoting the food processing industry in areas under organic farming** so that agro-based industrialisation can also be encouraged in those areas. The government is also promoting the **cultivation of herbs to increase the supply of herbal products** in the country which can also be exported.
- The government has approved the **Agriculture Infrastructure Fund** of Rs one lakh crore. Encouraging private investment through this fund will lead to the all-round development of rural areas for agricultural activities across the country,
- Fisheries, animal husbandry, herbal farming, beekeeping, and agricultural entrepreneurship are being promoted through the **Innovation and Agri-Entrepreneurship Development Program** under the **National Agriculture Development Scheme**.
- Recently a state-of-the-art **honey testing laboratory** of international standard has been set up in Anand, Gujarat.
- The government has made efforts to bring prosperity to the farmers by connecting more and more with schemes like **Pradhan Mantri Fasal Bima Yojana, PM Kisan, and Kisan Credit Card**.
- **'One Country One Market'** has been introduced and **Mandi Act** has been amended so that farmers can get a fair price for their produce. With the implementation of the **Farming Produce Trade and Commerce (Promotion and Facilitation) Ordinance**, now farmers can sell their crops anywhere in the country.

#### PKVY

- Simple and cost-effective **Participatory Guarantee System certification**
- Organic products sold by farmers on **Jaivik Kheti Portal**
- 6 lakh ha Area covered under Organic Farming – Additional 25 lakh ha planned.

- The **Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services Ordinance, 2020**, is also a landmark decision of the Government for the agriculture sector. Its main objective is to establish a legal order for agricultural agreements between farmers and sponsors so that farmers get fair and remunerative prices for their products.
- The Government has **increased the minimum support prices (MSP)** of Kharif crops for 2020- 21 marketing season. These prices are fixed by adding a 50 % to 83 % profit on the cost of production.
- Government has announced setting up of **10,000 Farmer Producer Organisations (FPO)** so that agriculture becomes a profitable business all over the country & small farmers get more empowered.

### **PRIORITISING AGRICULTURE AND ITS RESEARCH NEEDS**

- The research system plays an important role in generating knowledge, which is one of the factors of production in modern farming. The success of agricultural sector, however, depends on how effectively the research system generates, acquires, utilises, and disseminates knowledge and solves the problems.
- Indian agriculture research system comprises ICAR institutes, Central and state Agricultural Universities (SAUs) and Krishi Vigyan Kendras (KVKs), corporate/private research facilities. **NABARD also conducts and supports research.**

### **Importance of Agricultural Sector**

- It contributes about **one-sixth to the national income** and **provides direct employment** to nearly 50 percent of the workforce. It is fundamental for **ensuring the food security** of the nation and one of the **major sources for foreign exchange** earnings.
- It influences the **growth of secondary and tertiary sectors** of the economy through its forward and backward linkages.
- **World Development Report 2008** released by World Bank emphasises that growth in agriculture is, on average, **at least twice as effective in reducing poverty**, compared to growth emanating outside agriculture.
- However, the performance of the agriculture and allied sectors has been below its potential in recent years and has often been characterised by fluctuating of growth.
- The low and fluctuating growth rate is an indication of many existing challenges in the agricultural sector: small & fragmented landholdings, high dependence on rainfed farming, degradation of natural resources due to practices such as imbalanced use of inputs, low scale of mechanisation and low input productivity of crops.

### **Agricultural Sector for Economic Recovery**

- During COVID-19 pandemic when most sectors of the economy are reported to be under significant stress, the agricultural sector continues to be promising and cushioning the economy.
- The **area sown under all major kharif crops is expected to be higher** than corresponding period during the last year.

### **Role of Agricultural Research**

- The food production in the country has increased to over 295 MT in 2019-20. Similarly, production of **horticultural crops has surpassed 300 MT.**
- the return on investment in agriculture research is comparable, if not better than other expenditure incurred to support the agricultural sector.

- A recently released book entitled '**Supporting Indian Farms the Smart Way**' shows that **every rupee spent on agricultural research and development, yields better returns** (11.2), compared to fertiliser subsidy (0.88), power subsidy (0.79), education (0.97).
- The focus of research policy should remain on improving efficiency of public research system and encouraging participation of private sector wherever possible.
- Further, the **barriers to technology transfer from labs to land** should be removed to stimulate technology transfer and growth. Three things that make technology transfer more effective are **extension, irrigation, and rural infrastructure**.

### **Agricultural Research Structure**

#### **I. Development of Agricultural Research System**

- The Famine Commission Report (released in 1880) was an important step for laying the foundation of agricultural research structure in India. It resulted in creation of the **Departments of Agriculture at the Centre** as well as in the Provinces.
- The next major step was the establishment of the **Imperial (now Indian) Agricultural Research Institute at Pusa, Bihar**.
- The Imperial Council of Agricultural Research (ICAR) was established in 1929 which was renamed as Indian Council of Agricultural Research (ICAR) after independence.
- After the **establishment of first KVK** in 1974 at Pondicherry, India has a vast network of over 700 KVKs as of January 2020. These KVKs are envisaged to play multiple roles of on-farm testing, front line demonstration, and capacity building of farmers.
- The **Agricultural Technology Management Agency (ATMA)** holds responsibility for technological dissemination activities at the district level.

#### **II. Future of Agri Research**

- **Higher Agri Research Spending** - There is need to increase the spending on agricultural research. The expenditure on agricultural research as percentage of agriculture-GDP has been low at around 0.40 percent during 2012-14.
- **Focus on Crop and Non-crop Sector** - Non-crop sector too needs emphasis since it is expected to be the pillar of future growth of agricultural sector.
- **For Small Holders and Women** - Two noteworthy trends in Indian agriculture have been the **prevalence of small holders** (86 percent of total farmers having 47.3 percent of land holding, **increasing feminisation of agricultural sector** with 73.6 percent of rural women workers being farmers with 12.6 percent of land holdings. Future research in agricultural sector may look to develop low-cost effective solutions to address the challenges being faced by the small holders and women.
- **Private Sector for Research-Extension**: There is a need to provide appropriate ecosystem to agripreneurs to enable them to innovate in the form of products, services etc.

#### **III. Role of NABARD**

- NABARD has established the R&D fund with a corpus of Rs 50 crore replenished annually. It aims at acquiring new insights into the problems of agricultural and rural development Few examples of important research studies sponsored by NABARD in recent years are:
- **NABARD Survey** - NABARD launched the '**NABARD All India Rural Financial Inclusion Survey**' in 2016-17 to gain deeper insights into the livelihood and financial inclusion aspects of households. It showed huge opportunities for investment in agri-infrastructure with the expansion of bank credit. The

survey also points towards some areas of concern. Particularly, with respect to **crop insurance the penetration is low at 7 percent.**

- **Water Productivity Mapping of Major Indian Crops** - This study has been carried out by NABARD in association with Indian Council for Research on International Economic Relations (ICRIER). It attempts to answer two primary questions -
  - i) Are the existing cropping patterns in India in line with the natural water resource endowments of various regions?
  - ii) Are these cropping patterns sustainable from a water-use perspective?
- The board finding of the study indicates that there are regions in India which are heading towards unsustainable agriculture with highly skewed distribution of water for certain crops. This is clearly visible in the case of sugarcane and rice.

**Way Forward**

- There is a need to increase spending on agricultural research & extension to address challenges
- **Bio-fortification** methods must be used to develop high quality crop varieties having high protein, zinc, irons, etc. nutritional content. The **plant breeders** need to use latest bio-technological methods in addition to traditional methods of farming.
- While emphasising on the need for ‘Smart Agriculture’, we need to go for a **‘technology revolution’** encompassing Big Data, Artificial Intelligence, Internet of Things, Computing and Block Chain, Nanotechnology, etc. to accelerate growth in agriculture sector.
- There is a need for the multi-stakeholder approach in generating and sharing knowledge, including traditional knowledge, for addressing production constraints and harness growth opportunities in agriculture.

**RESEARCH AND DEVELOPMENT FOR SUSTAINABLE AGRICULTURE**

India has become one of the world’s largest producers of food grains, spices, milk, etc. The country has produced a record 295.67 Million Tonnes (MT) of food grains, 33.50 MT Oilseeds, 358.14 MT Sugarcane, 36.05 million bales of cotton and 9.92 million bales of jutes and mesta during 2019-20. The country is expected to register a bumper horticulture production of 320.48 MT during 2019-20.

Major focus has been laid on achieving self-sufficiency in food grains production right from the 3<sup>rd</sup> Five-Year Plan (1961- 1966) by enabling the emergence of an improved R&D atmosphere in the country.

**Sustainable Agriculture Process**

Sustainability of agriculture stands on **three pillars viz. economic, environment and social development.**

<b>Pillars of Sustainable Agriculture</b>		
<p><b>Economic</b></p> <ul style="list-style-type: none"> <li>• High yield, Productivity</li> <li>• Income Generation</li> <li>• Reduced Cost</li> <li>• Profit, GDP</li> <li>• Employment, Industry &amp; Trade</li> </ul>	<p><b>Social</b></p> <ul style="list-style-type: none"> <li>• Collaboration</li> <li>• Local Market</li> <li>• Community Development</li> <li>• Price Protection</li> <li>• ‘Energy Saving</li> </ul>	<p><b>Environment</b></p> <ul style="list-style-type: none"> <li>• Food security</li> <li>• Food quality</li> <li>• Food waste</li> <li>• GHG Emissions</li> <li>• Energy Savings</li> </ul>

	<ul style="list-style-type: none"> <li>• Transparency</li> <li>• Youth Development</li> </ul>	<ul style="list-style-type: none"> <li>• Water Footprints</li> <li>• Nutritional Security</li> </ul>
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- The R&D aspects not only provide research outputs for rolling out sustainable farm practices but support in making quality physical, human and environmental resources available to farming community.
- Innovative agriculture practices have helped in maximising the profit, reducing wastes and the social Impact focusing on livelihood and rural employment.

### Agriculture Inputs

- **Seed:** Production of breeder, foundation and certified seeds resulted in sustaining the agriculture. ICAR developed various drought resistant and hybrid seeds to sustain and improve agriculture, Genetic manipulation of crops has resulted in increasing the yield of crops too.
- **Fertilizers:** Nutrient Based Subsidy Scheme (2010) focused on efficient targeting of subsidised fertilizers. The recent research and application of **Neem Coated Urea** in the field have not only reduced the consumption of chemical fertiliser and improved the quality of the soil, but also became largely responsible for restricting diversion of Urea for purposes other than agriculture.
- As in March 2020, about 1.8 percent of the total cultivable area (27.7 lakh hectare) has been covered under organic cultivation in the country. Government has been promoting **Integrated Nutrient Management** and farmers are advised to use biofertilisers, organic manure in conjunction with chemical fertilisers to maintain fertility of soil. Further, Nanofertilisers, a recently launched product has immense potential for ensuring soil health through efficient management of fertility for improved crop production,
- **Agro Chemicals:** R&D has resulted in manufacturing of various insecticides, pesticides and herbicides to protect the agriculture yield. Integrated Pest Management System is an initiative in agriculture to control pests and insects by combining biological, cultural and chemical practices.
- **Farm Machinery and Equipment:** Recent R&D in technology have resulted in the production and use of different and innovative agri-equipment like tractors, balers, planters and sprayers, etc. The Union Government has launched two mobile applications viz. **CHC Farm Machinery and Krishi Kissan App**. While the former aims at facilitating and maximising farm mechanisation through networking with custom hiring centres in a short span of time, the later envisages, demonstration of high-yielding variety (HYV) of crops and seeds, geo-fencing and geo-tagging of crops.

### Smart Agriculture

- Smart agriculture is a global initiative to ***maintain sustainable agriculture through judicious use of improved and updated technology***. Precision farming is one such initiative in agriculture using Internet of Things (IoT) and IT.
- Some of the future-oriented smart agri-technology which needs investment and implementation are deliberated as follows:
  1. **Farm Management Information System (FMIS)** provides various information at a given period instantly which includes data on soil sample, weather conditions, sensor data, maps, etc. It helps in **taking right farming decisions at an appropriate time**.
  2. **Geographical Information System** - It examines and analyses the wider range of agricultural-related resources which are important parameters of crop productivity.
  3. **Nanotechnology** has prospects for integrated pest and nutrient management involving processes for pest disease control, efficient fertiliser applications with minimised nutrient loss.

4. **Artificial Intelligence** helps in capturing images and identifying pests and plant diseases for better agricultural administration at field level. Machine Learning algorithms provide for *digital mapping of crop health and ground level moisture*. IoT for Agriculture has built in mechanism for monitoring crop fields with the help of sensors (light, humidity, temperature, soil moisture, etc.) and automating the agriculture practices.
5. While **LED Lighting ensures a precise control of photoperiod**, soil, and environmental sensors, **drones can perform several significant tasks** like application of fertiliser, pesticides, crop monitoring, crop estimation and damage assessments, etc.

#### **Clean and Green Agriculture**

- Significant losses from fruits and vegetable Processing industries have become a serious concern for the pillars of Sustainable Agriculture.
- The wastes generated from agro-based industries can be utilised either for disposal to avoid contamination of ground and surface water or **they can be valorised in a bio-methane plant** that needs additional input and generates compost which can be directly supplied to local farmers.
- Researchers have paved a road map for reuse, reduce and recycle of agriculture by-products and wastes for sustaining the environment and social aspects. There is a huge **potential to convert crop residues and food/ plant wastes into bio-fuel**.

#### **Conclusion**

- Farming in India is a complex and high-risk business in the wake of climate change, water scarcity and land degradation.
- To address the risks and challenges, the country needs to address multiple developmental challenges ranging from sustainable natural resource management to community led inclusive growth, food security and environmental safety.
- Sustainable development of agriculture depends on how well our **farmers are sensitised about the recent advances** in the R&D of agri-technology and their just applications towards efficient and effective management of agriculture

#### **STRATEGIES TO BOOST INDIA'S GLOBAL AGRICULTURE TRADE**

- Fallouts of the pandemic in the form of lockdowns, reverse migration from urban to rural areas, etc. have **affected both the global supply chain and the demand** for agricultural products.
- WTO has forecasted that in 2020 global trade will plunge between 13 percent and 32 percent due to the ongoing pandemic. Hence, India is relying on the resilience of its agriculture sector to revive the economy.

#### **Agricultural Exports**

- Agriculture accounts for a vital part of the Indian economy, accounting for 17 percent of Gross Value Added, and **11 percent of India's trade with the rest of the world**.
- In 2019-20, while **agricultural exports from India were \$33.9 billion**, i.e. 10.8 percent of India's total merchandise exports, **agricultural imports stood at \$19.9 billion**, accounting for 4.2 percent of India's total merchandise imports.
- There are more than **130 agricultural products and food items** which have been accorded **Geographical Indications in India**.

## Challenges Faced by Agricultural Export

### A. Reverse Migration

- **Reverse migration**, due to the pandemic, has resulted in a shortage of agricultural workers at affordable rates in some States, thereby adversely affecting the supply side of agricultural exports.

### B. Trade Constituents and Constraints

- The top five agricultural commodities which were exported from India in 2019-20 accounted for almost 64 percent of India's agricultural exports. Cereals constituted about 20 percent of India's agricultural exports.
- The top five destinations of the top five exports constituted a major share, **indicating the need for diversification of products** for exports and to **tap potential newer markets**.

### C. Trade Barriers

- Trade barriers may take the form of **tariffs or non-tariffs**. While the former includes the imposition of customs duties which raise the price of the import and erode their competitive edge; the latter entails quotas, subsidies, prohibitions, standards, etc. which make it difficult to penetrate the destination market.
- A large number of developed countries, including Korea and Norway, protect their agricultural sector by imposing high rates of tariffs. It is important to note that despite the pandemic, **India has not imposed any export restrictions on agriculture**.
- Over the years, developed countries have moved from tariffs to non-tariff barriers. In 2018, the **EU reduced the permissible level of a fungicide in imports of rice**, citing health reasons. Consequently, India's rice exports, especially basmati, had taken a hit.
- Steps to ensure **symmetry of information with all stakeholders** will ensure that Indian agricultural exports do not face border rejections due to physical, chemical or microbiological regulations of the destination countries.
- **Specifications on slaughter houses** put in place by certain countries make exports of meat from India difficult to these countries. Some destination markets have banned the import of Indian meat because of **reports of foot and mouth disease** from some parts of the country.
- The **requirement of a health certificate** from the government of the destination country acts as a deterrent both in terms of being expensive and also being time consuming.
- **Different sets of regulations** for countries in the same region may pose problems for Indian exporters. E.g. the specifications of rice required are different in various ASEAN countries.

### Some Recent Developments

- Agriculture and allied sectors were exempted from the lockdowns and the thrust was on ensuring uninterrupted harvesting and availability of food grains.
- Benefits were extended to farmers on crop loan repayments. The **CROP software** of Central Insecticide Board & Registration Committee was used to facilitate issuance of certificates.
- The launching of the **Kisan Rath app** facilitated farmers and traders in identifying suitable modes of transport for movement of agricultural produce. Besides, **All India Agri Transport 24X7 Call Centres** too have been launched.
- Two new modules, viz. **warehouse-based trading module** and **FPO module** were added to the **National Agriculture Market (e-NAM) portal** to facilitate farmers to sell their produce from Warehousing Development and Regulatory Authority registered warehouses notified as deemed



markets; and to enable FPOs to upload their produce from collection centres for on-line bidding, respectively.

- The setting up of an **Animal Husbandry Infrastructure Development Fund** would be useful for investments, in dairy, meat processing and animal feed plants.
- In its report, 15th Finance Commission's High Level Group on Agricultural Exports recommended a **State-led export business plan for a crop value chain cluster as an integral link in the value chain.**

## **WTO & Agriculture**

- India's agriculture is an important constituent of the global agricultural value chain. Therefore, it is imperative that the remuneration that the farmers receive is more than the subsistence level.
- In this context, it is essential to note that **WTO has set the subsidy limit at 10 percent of total value of food production** for developing countries and in case of a breach, action by other member countries may be avoided under the 'Peace Clause'.
- **India is the first country to invoke the 'Peace Clause' for breaching the subsidy limit for rice in 2018-19.**
- India's food security programmes have the **triple objectives** of providing minimum support prices for farmers, stabilising food grain prices and ensuring their equitable distribution at affordable rates to the needy.
- Another case related to **subsidies is those given to small fishermen.** India's stand in the WTO has been to seek a 'carve-out' for them from the negotiations which are going on for ending subsidies for illegal, unreported and unregulated fishing.
- The recently approved scheme of the Government of India called **Remission of Duties and Taxes on Exported Products is WTO-compliant.** By reimbursing taxes/duties/levies at the central, state and local level, the scheme will provide a level playing field to Indian exporters.

## **Way Forward**

### **1. Accessibility of Farmers**

The Government has recently amended the Essential Commodities Act and passed the Farming Produce Trade and Commerce (Promotion and Facilitation) Ordinance, 2020 and the Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services Ordinance, 2020. Effective implementation of these would ensure affirmative steps towards mitigating farmers' accessibility issues to markets, processors, wholesales, aggregators, large retailers and exporters.

### **2. Farmers' Producer Organisations**

Collectivizing the strengths of small farmers may go a long way in specialisation and export-orientation of products by efficiently utilising economies of scale.

### **3. New Products, New Markets and R&D**

As a long-term strategy, new products for exports and new destinations may be explored. The choice of new products/crops needs to be prudent, lest scarce resources like water get indiscriminately depleted. A move towards exporting higher value products and hitherto untapped ones, like horticulture, would, undoubtedly ensure more foreign exchange.

### **4. Trade Agreements**

One way to thrash out both tariff and non-tariff issues is to negotiate these in bilateral, plurilateral or regional trade agreements.

## 5. Alerts

Putting In place an online system of alerts on imports which do not match Indian specifications/ standards may be a potent tool for negotiators of trade agreements with other countries. A database of incidents of rejections and detentions of consignments may be useful in maintaining a minimum quality of Imports,

## 6. Facilitation

It Is Imperative to make the farmers aware of the non-tariff barriers in the destination countries. Apart from reaching out to the farmers, it is also important to have their inputs/views prior to any trade negotiations. **Inputs from the farmers regarding four aspects is vital**, viz. **sensitive products** which cannot be allowed to be Imported; **competitive products** which can withstand competition from Imports, **products which face tariff or non-tariff barriers** in destination markets and **potential exportable products** which require market access In other countries.

## Conclusion

- The World Bank's 'Ease of Doing Business, 2020' shows an improvement in India's performance under the head 'Trading Across Borders', with India's rank having jumped up from 80 in 2019 to 68 in 2020.
- A focussed approach to fill the void created by disruptions in the supply chain in the current pandemic situation may be gainful for India's agricultural trade.
- India's current share in global trade may be less than 2 percent, yet the encouraging fact is that positive steps have been made towards doubling farmers' income and boosting India's agricultural trade.

## INNOVATIVE PRACTICES FOR SMART AGRICULTURE

Food and Agriculture Organisation (FAO) estimates that agricultural production will have to increase by 60 percent by 2050 to satisfy the expected demands for food and feed. Climate change will continue to make this task more difficult. Hence, Agriculture must transform itself.

### What is Climate Smart Agriculture?

- FAO defined climate-smart agriculture (CSA) as the **three dimensions of sustainable development (economic, social and environmental)** by jointly addressing food security and climate challenge. These three main pillars are as follow:
  - i) Sustainably Increasing agricultural productivity and income;
  - ii) Adapting and building resilience to climate change.
  - iii) Reducing and/or removing greenhouse gases emissions, where possible.
- It involves the **integration of advanced technologies** into existing farming practices in order to increase production efficiency and the quality of agricultural products.
- Smart or precision agriculture has become the **third wave of the modern agriculture revolution** (the first was mechanisation and the second the green revolution with its genetic modification).

### Innovative Practices for Higher Resource Use Efficiency

1. **Precision in Seed Sowing and Planting** Effective seeding requires control over two variables: planting seeds at the correct depth, and spacing plants at the appropriate distance apart to allow for optimal growth. Precision seeding equipments are designed to maximise these variables every time. Combining geo-mapping and sensor data detailing soil quality, density, and moisture and nutrient levels takes a lot of the guesswork out of the seeding process. In future, **existing precision seeders**

will come together with autonomous tractors and ICT enabled systems that feed information back to the farmers.

2. **Precision in Nutrient Management** - It is the solution to manage special variability of nutrients and better nutrient use efficiency.
  - i) **Smart Fertilisers:** Nanotechnology based smart fertilisers development with an emphasis on controlled release systems will synchronise nutrient availability with the plant demands thereby reducing nutrient losses. Increased nutrient use efficiency has reduced dose of phosphate by half to one fourth and increased yields by 10 percent.
  - ii) **Leaf Colour Chart:** Leaf colour is a fairly good indicator of the nitrogen status of plant. The leaf colour chart has been developed by International Rice Research Institute, Philippines. Studies indicate that nitrogen can be saved from 10 to 15% using this chart.
  - iii) **Nutrient Expert (NE):** It is a nutrient decision support system, based on site-specific nutrient management principles. NE provides fertiliser recommendations by considering yield responses and targeted agronomic efficiencies along with contribution of nutrients from indigenous sources.
  - iv) **Urea Deep Placement (UDP):** UDP technique, is a good example of a climate-smart solution for rice systems. This technique decreases nitrogen losses by 40 percent and increases urea efficiency to 50 percent.
3. **Innovative Practices for Efficient Water Management**
  - i) **Automation Irrigation System:** By pairing these irrigation systems with increasingly sophisticated internet of things (IoT)-enabled sensors farmers will be able to intervene only when necessary, otherwise allowing the system to operate autonomously.
  - ii) **On-farm Reservoir (OFR):** Rainwater harvesting, and efficient water use are inevitable options to sustain rainfed agriculture in future.
  - iii) **Deficit Irrigation Supplies:** Under limited water availability condition, irrigation strategies based on meeting the partial crop water requirements should be adopted for more effective and rational use of water.
4. **Innovative Practices for Weed and Pest Management**
  - i) **New Generation Herbicides:** These herbicides have been very effective in controlling weeds in filed crops.
  - ii) **Herbicide Resistant Crops (HRCs):** Herbicide resistant Crops are genetically modified (GM) crops engineered to resist specific broad- spectrum herbicides, which kill the surrounding weeds, but leave the cultivated crop intact.
  - iii) **Artificial Intelligence and Automation in Weed Management:** With advanced machine learning, or even AI machines could entirely replace the need for humans to manually weed or monitor crops. Using a combination of GPS, laser measurement and ultrasonic positioning; crop-spraying drones can adapt to altitude and location easily, adjusting for variables such as wind speed, topography and geography. This enables the drones to perform crop spraying herbicides, fertilisers and pesticides more efficiently, and with greater accuracy and less waste. These robots designed for weeding, with the same base machine can be equipped with sensors, cameras and sprayers to identify pests and application of insecticides.
5. **Innovative Resource Conserving Practices**
  - i) **Laser Land Levelling:** Precision land levelling is another resource conservation technology. Yield advantage in both direct seeded rice and transplanted rice and saving of 20- 25 percent of

irrigation water apart from several other benefits like better crop establishment, nutrient use efficiency, uniform irrigation etc. have been reported with laser land levelling.

- ii) **Raised-bed Planting:** Raised-bed planting refers to growing of crops (wheat, maize, pigeon pea and horticultural crops) in row geometry and on raised beds with furrow irrigation arrangements using a multi-crop raised bed planter. It helps in saving irrigation water as furrows act as drainage channel in case of heavy rains and hence save crops from excess moisture.
- iii) **Conservation Tillage:** Conservation tillage practices range from zero tillage (No-till), reduced (minimum) tillage, mulch tillage, ridge tillage to contour tillage. Conservation tillage farming is a way of growing crops without disturbing the soil through tillage using zero-till planter/drill. It increases the amount of water that infiltrates into the soil and increases organic matter retention and cycling of nutrient in the soil.

## 6. Innovative Practices for Higher Productivity and Profitability

- i) **Crop Diversification** - It is the most important agricultural activity providing employment and food security to millions of people in the country. Crop diversification can be practiced in two ways i.e. temporal/horizontal/crop rotational diversification and spatial/vertical diversification.
- ii) **Integrated Farming Systems (IFS)** - IFS is adoption and integration of wide ranges of resource saving package of practices, which ensures acceptable levels of profits and make the whole system economically sustainable. In IFS approach emphasis is given on diversification of cropping systems.
- iii) **Conservation Agriculture (CA)** - The key features of CA are 3 basic principles: 1) Minimum soil disturbance, 2) Maximum soil cover by leaving and managing the crop residues on the soil surface, 3) Crop diversification. The main advantages of CA are reduction in cost of production, reduced incidence of weeds, saving in water and nutrients, increased yields, environmental benefits, crop diversification opportunities, improvement in resource-use efficiency.
- iv) **Organic Farming** - Organic food products are considered to be much safer and nutritious than the products produced by the conventional farming. Organic farming also helps to restore the soil health, protect environment, enhance biodiversity, sustain crop productivity and enhance farmers' income. Organic produces are being sold at premium price which increase farmers' income.

## SUSTAINABLE CROP PRODUCTION

Agricultural growth has been volatile having an impact on farm incomes as well as farmers' ability to invest that can be sustained by promotion of sustainable crop production practices.

### **Agricultural Achievements**

- India is the largest producer (25 percent of global production), consumer (27 percent of world consumption) and importer (14 percent) of pulses in the world.
- It is also the largest producer of jute and the second-largest producer of rice wheat, sugarcane, cotton and groundnuts, as well as the second-largest fruit and vegetable producer accounting for 10.9 percent and 8.6 percent of the world fruit and vegetable production, respectively.
- **Sustainable crop production intensification** is being emphasised to **produce more from the same area of land while reducing negative environmental impacts.**

### **Sustainable Agriculture**

- To be sustainable, agriculture must meet the needs of present and future generations for its products and services, while ensuring profitability, environmental health, and social and economic equity.

- Sustainable agriculture contributes to all **four pillars of food security i.e. availability, access, utilisation and stability** in a manner that is environmentally, economically and socially responsible over time.

### **Soil Health Management**

- The ideal NPK (nitrogen, phosphorous, potassium) proportion for the Indian soil is 4:2:1. The ratio of NPK in Punjab and Haryana was 19.2:5.5:1 and 20.6:6:1 respectively in 2011.
- With the increasing availability of low-cost fertilisers, the importance of organic manure is largely ignored by farmers. **Practices like intensive cultivation and residue burning** has further reduced the organic carbon content in soil.
- **Organic amendments** such as farm yard manure, green manure, compost, vermicompost, etc. need to be added to soil regularly to increase its organic matter content of the soil. **Growing of legumes as green manuring crops** protects soil from erosion by keeping the soil covered as well as adds organic matter, fixes nitrogen, improves soil structure and other beneficial effects.
- The Government of India launched the **Soil Health Card scheme** in 2015 to give each farmer soil nutrient status of his holding and advise him regarding dose of fertiliser application.

### **Conservation Agriculture (CA)**

- CA is a farming system that promotes minimum soil disturbance (i.e. no tillage), maintenance of permanent soil cover and diversification of plant species.
- It addresses several challenges like increasing soil carbon storage and decreasing GHGs, promoting sustainable agriculture, preserving environment, natural resources and biodiversity.
- **Reducing tillage increases organic matter** and sequestration of carbon in soil, as well as improves its structure and water retention capacity.
- A permanent soil cover is maintained through retention of adequate level of crop residues on soil surface. **Maintaining a soil cover helps reducing** the deleterious impact of rain drop and wind on soil, thus reducing soil erosion. Moreover, the surface residue allows more water to infiltrate into soil rather than freely flowing to river or sea.
- Another key principle of conservation agriculture is **crop diversification**. It helps in moderating weed, disease and pest problems, takes advantage of biological nitrogen fixation when legume is included in the rotation and minimised risk.

### **Crop Residue Management**

- The **problem of stubble burning** has resulted in an uncomfortable public life. Burning of crop residues removes huge amount of nutrient from soil. In addition to this, generation of shoots, carbon monoxide, carbon dioxide & other toxic gases cause air pollution leading to multiple health issues.
- **In situ management of crop residue** can be done through conservation agriculture practice. Instead of burning crop residues, the crop residues can also be used for alternate beneficial use such as compost production, bioenergy production, biochar production, in pulp and paper industry etc.
- A Central Sector Scheme on '**Promotion of Agricultural Mechanisation for In-Situ Management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi**' was approved for the period from 2018-19 to 2019-20.

### **Integrated Nutrient Management**

It refers to maintenance of soil fertility and plant nutrient supply at an optimum level for sustaining desired productivity through optimisation of the benefits from all possible sources of organic, inorganic and biological components in an integrated manner. The components of INM include:

- i) **Soil Source** - The nutrient status of soil must be monitored at regular interval. Any unfavourable soil conditions like high soil acidity or soil salinity should be reclaimed to improve the nutrient availability to plant.
- ii) **Mineral Fertilisers** - A part of the nutrient requirement of crop can be met by using synthetic fertilisers like urea, SSP, DAP etc.
- iii) **Organic Sources** – In addition to supplying nutrient, addition to supplying nutrient, organic sources also improve soil organic carbon content of soil.
- iv) **Biological Sources:** Biofertilisers can be used as a source of nutrient. They can supply nutrient either by fixing nitrogen from atmosphere or by improving the availability of soil nutrient through solubilisation and mobilisation.

#### **Integrated Pest Management**

- FAO defines Integrated Pest Management as careful consideration of all available control pest techniques and subsequent integration of appropriate measures that discourage development of Pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimise risks to human health and environment.
- As IPM reduces dependence on chemical Pest control, it also helps delay the risk of pesticide resistance development.

#### **Inclusion of Legumes in Cropping System –**

Legumes are known for their nitrogen fixing ability. Legumes add nitrogen to the soil through nitrogen fixation, improves phosphorus availability through rhizosphere modification and helps in nutrient cycling by bringing the subsoil nutrient to the top soil through its deep root system.

#### **Climate Smart Agriculture –**

- It is an approach for developing strategies to secure sustainable food security under changing climatic scenario.
- To meet the challenge of Climate change on sustainability of Indian agriculture, ICAR has launched **National Innovations on Climate Resilient Agriculture (NICRA)** in 2011 that has been evolving climate resilient agricultural technologies and also demonstrating best practices that can help farmers to cope with current climate Variability.

#### **Resource Conserving Technologies**

- Injudicious or over use of resources not only adds unnecessary cost to the Production process but also negatively affects environment. Resource conserving technology like zero tillage can be very helpful.
- **Use of GIS and GPS for precise agricultural** input management (precision farming) can also be considered as a resource conserving technology. Permanent raised bed or furrow irrigated raised bed will reduce the cost of land preparation in long run.

Initiatives taken by Gol to Promote Sustainable Agriculture:

1. **National Mission on Sustainable Agriculture (NMSA)** seeks to address issues regarding sustainable agriculture in the context of risks associated with climate change by devising appropriate adaptation and mitigation Strategies.
2. **Paramparagat Krishi Vikas Yojana (PKVY)** aims at development of sustainable models of organic farming through a mix of traditional| wisdom and modern science to ensure long term soil fertility build up, resource conservation and helps in climate change adaptation and mitigation.

3. **Pradhan Mantri Krishi Sinchayee Yojana** (PMKSY) seeks to extend the coverage of irrigation with improved access to irrigation and water use efficiency.
4. **Soil Health Card Scheme** is aimed at improving soil fertility on a sustainable basis.

**Conclusion**

- A Paradigm shift is required for enhancing system productivity and sustainability. Sustainable crop production practices must be Promoted among farmers.
- Farmers' feedback on these technologies/ practices should be taken into consideration and necessary changes must be made to address the farmers' concern. Financial assistance may be given to farmers.
- Sustainable agriculture not only helps achieving the ever-existing target of food and nutritional security, but also aims at ecological balance and social security. It not only cares for the needs of present generation but also for the generations to come.