

Gist of

# KURUKSHETRA

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September 2020

## AGRICULTURAL RESEARCH



**Rejuvenation of Agriculture**  
through Research

**Prioritising Agriculture**  
and its Research Needs

**Agricultural Research** for  
Food Security and Income

**Research and Development** for  
Sustainable Agriculture

Strategies to **Boost India's**  
**Global Agriculture Trade**

# Outstanding performance by BYJU'S students in IAS 2019

Congratulations to our toppers

**04**

Ranks in  
Top 10

**09**

Ranks in  
Top 20

**13**

Ranks in  
Top 50

**22**

Ranks in  
Top 100



**RANK 03**

Pratibha Verma



**RANK 06**

Vishakha Yadav



**RANK 08**

Abhishek Saraf



**RANK 10**

Sanjita Mohapatra



**RANK 11**

Nupur Goel



**RANK 12**

Ajay Jain



**RANK 14**

Anmol Jain



**RANK 16**

Gunjan Singh



**RANK 19**

Shresta Anupam



**RANK 23**

Nidhi Bansal



**RANK 24**

Abhishek Jain



**RANK 30**

Pari Bishnoi



**RANK 34**

Apurv Chauhan



**RANK 52**

Om Kant Thakur



**RANK 56**

Pankaj



**RANK 66**

Saurav Pandey



**RANK 69**

Navneet Mittal



**RANK 81**

Anil Kumar Rathore



**RANK 84**

Jivani Kartik Nagjibhai



**RANK 85**

Shubhank Mishra



**RANK 96**

Hardik Aggarwal



**RANK 98**

Y Megha Swaroop



# INCREDIBLE RESULTS

## CSE 2018 Results

11 Ranks in Top 50

28 Ranks in Top 100

183 Ranks in the Final List



Rank 11  
Puja Priyadarshni



Rank 16  
Dhodmise Trupti Ankush



Rank 21  
Rahul Jain



Rank 24  
Anuraj Jain

## CSE 2017

5 Ranks  
in top 50

34 Ranks  
in top 100

236 Ranks  
in the final list



Rank 3  
Sachin Gupta



Rank 6  
Koya Sree Harsha



Rank 8  
Anubhav Singh



Rank 9  
Soumya Sharma



Rank 10  
Abhishek Surana

## CSE 2016

8 Ranks  
in top 50

18 Ranks  
in top 100

215 Ranks  
in the final list



Rank 2  
Anmol Sher  
Singh Bedi



Rank 5  
Abhilash Mishra



Rank 12  
Tejaswi Rana



Rank 30  
Prabhash Kumar



Rank 32  
Avdhesh Meena

## CSE 2015

5 Ranks  
in top 50

14 Ranks  
in top 100

162 Ranks  
in the final list



Rank 20  
Vipin Garg



Rank 24  
Khumanthem  
Diana Devi



Rank 25  
Chandra Mohan  
Garg



Rank 27  
Pulkit Garg



Rank 47  
Anshul Agarwal

## CSE 2014

6 Ranks  
in top 50

12 Ranks  
in top 100

83 Ranks  
in the final list



Rank 4  
Vandana Rao



Rank 5  
Suharsha Bhagat



Rank 16  
Ananya Das



Rank 23  
Anil Dhameliya



Rank 28  
Kushaal Yadav



Rank 39  
Vivekanand T.S

## CSE 2013

5 Ranks  
in top 50

62 Ranks  
in the final list



Rank 9  
Divyanshu Jha



Rank 12  
Neha Jain



Rank 23  
Prabhav Joshi



Rank 40  
Gaurang Rathi



Rank 46  
Udit Singh

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Stay safe and Keep Learning!

**Team BYJU'S**

## KURUKSHETRA – SEPTEMBER 2020

### AGRICULTURAL RESEARCH

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## Chapter 1: Rejuvenation of Agriculture Through Research

### Significance of research in the agricultural sector:

#### **Economic:**

- Agricultural production has become the axis of the country's economy today. The use of high tech solutions emanating from agricultural research can help increase agricultural production and productivity and aid in the economic growth of the country.
- The research system plays an important role in generating knowledge, which is one of the factors of production in modern farming.
  - The well-known agricultural scientist and the then President of the National Farmers Commission, [Prof. M. S. Swaminathan](#) had in his report recommended a steady increase in public investment for the agriculture sector, especially for improvement in irrigation, drainage, land development, water conservation, research development, road connectivity and development of agricultural infrastructure.

#### **Social:**

- Agricultural research can help increase agricultural production and productivity and thus aid in improving the economic condition of the farmers. This economic upliftment will have a marked impact on the social empowerment of this vulnerable section of society.

### Addressing challenges and risks:

- The focus of research in the agricultural sector would not only be on production but also on reducing agriculture-related risks. This could help address the challenges (climate change, pest resistance, and decreasing fertility of soil) of the sector and reduce the risk posed by them.
- There is a need to increase spending on agricultural research and extension to address challenges such as achieving inclusive growth, improving resistance to crops to climate change, improving the nutritional quality of food and improving resource use efficiency.
- Bio-fortification methods have been used to develop high-quality crop varieties having high protein, zinc, iron, etc. in nutritional content. Plant breeders have been using the latest biotechnological methods in addition to traditional methods of farming.

### Indian Council of Agricultural Research:

- The Indian Council of Agricultural Research (ICAR) was established in 1929 to promote agricultural research in the country.
- The ICAR is playing a pivotal role in guiding, managing, and coordinating activities and functions related to the agriculture sector, including horticulture, fisheries development, animal science, agriculture education and research.
- There are, at present, 102 research institutes and 71 agricultural universities affiliated to ICAR, across the country.
- This organisation has established a vast network of 718 [Krishi Vigyan Kendras \(KVKs\)](#) for extension and spread of its valuable agricultural research benefits including the development of high yielding varieties of crops, high milk yielding cattle species, and development of the horticulture sector.

### Agricultural research:

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

- A total of 220 crop varieties have been notified and released for commercial cultivation in the year 2019-20, including crops such as rice, maize wheat, sorghum, millet, linseed, and ragi. This includes varieties that are climate-friendly, multi-stress tolerant varieties and bio-fortified varieties of various crops.
  - Pusa Basmati, developed by ICAR, is the world's longest kernel of paddy. It is the most sought after rice variety in the world. A substantial worth of foreign exchange is being earned every year by exporting this variety.
  - The productivity of sugarcane variety CO-023B, 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- 'ArkaRakshak' and 'ArkaSamrat' have been developed to ensure bumper production.
  - The ICAR has developed 53 bio-reinforced varieties of foodgrains between 2014 and 2019 proved to be useful in alleviating [malnutrition](#).
- Apart from developing new crops, the ICAR has been pro-active in ensuring the adoption of these novel varieties at scale. Under the 'zero edible oil import' policy, ICAR has conducted more than 50 thousand national level cluster frontline demonstrations on oilseed crops in the last one year.

### **Livestock Development Research:**

- During the period 2014 - 2019, 40 new animal species have been registered and notified.
- During these five years, ten vaccines have been developed to combat animal diseases.
- An active surveillance system has also been developed to make India free from Foot and Mouth (FMD) disease by 2024.

### **Horticulture Sector:**

- Currently, India ranks first in horticultural production. The horticulture sector has emerged as a significant agro-enterprise in giving momentum to the Indian economy.
- 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.

### **Agricultural Education:**

- The Indian Council of Agricultural Research and our agricultural colleges have made exceptional progress in agricultural engineering education. New programmes and modules have been developed.
- The focus of agricultural research has not been only on production but also on giving scientific form to marketing, processing, and agricultural operations.

### **Way forward:**

- There is the urgent need to focus on the multi-faceted development of the agriculture sector, through the application of scientific methodology, innovations and optimum use of modern technology in agriculture.
- While emphasising on the need for 'Smart Agriculture', there is the need for a 'technology revolution' encompassing Big Data, [Artificial Intelligence](#), Internet of Things, Computing and Blockchain, Nanotechnology, etc. to accelerate growth in the agriculture sector.



- The agricultural research system should generate, acquire, utilize and disseminate knowledge so generated at speed and scale.
- Agricultural technology should be cost-effective rather than expensive so that every farmer can use it.

### **Additional information:**

#### **Governmental measures in the agricultural sector:**

- In July 2019, the Prime Minister constituted a high-powered committee of Chief Ministers to “rejuvenate Indian agriculture”.
- 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 government has been emphasising on promoting the export of agricultural products.
  - 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. Europe ranks first with agricultural exports valued at \$181 billion.
- 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.
- 'One Country One Market' concept is being encouraged through the [eNAM](#) programme.
- The Government has taken some landmark decisions in the sector.
  - The APMC Act has been amended to ensure that farmers 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.
  - 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 system of electronic trade and e-platform for agricultural produce will free the farmers from the difficulties arising out of physical trade/sale of the produce.
- The government has announced the setting up of 10,000 [Farmer Producer Organizations \(FPO\)](#) so that agriculture becomes a profitable business all over the country and small farmers get more empowered.



## Chapter 2: Prioritising Agriculture and its Research Needs

### Significance of the Agricultural Sector in India:

- Agriculture contributes about one-sixth to the national income.
- It provides direct employment to nearly 50 percent of the workforce in India.
- Agriculture influences socio-economic outcomes as well in the nation. The [World Bank](#) emphasises that growth in agriculture is, on average, at least twice as effective in reducing poverty, compared to growth emanating outside agriculture. Agricultural growth reduces poverty directly, by raising farm incomes, and indirectly, through generating employment and reducing food prices.
- It is fundamental for ensuring the food security of the nation and one of the major sources for foreign exchange earnings.
- It also influences the growth of secondary and tertiary sectors of the economy through its forward and backward linkages.

### Agricultural Sector for Economic Recovery:

- Agricultural sector would help feed and employ thousands who might have lost livelihoods due to the pandemic. The agricultural sector continues to be one of the bright spots amidst this pandemic. The focus on the agricultural sector could help ensure speedy economic recovery of the country.

### Agricultural sector in India:

- The performance of the agriculture and allied sectors has been below its potential in recent years and has often been characterised by fluctuating growth.
- This seems to be an indication of many existing challenges in the agricultural sector: small and fragmented landholdings, high dependence on rain-fed farming, degradation of natural resources due to practices such as imbalanced use of inputs, the low scale of mechanisation and low input productivity of crops.

### Role of Agricultural Research:

- Agricultural research has had a substantial role in the expansion of food grain output from nearly 51 million tonnes (MT) in 1950-51 to over 295 MT in 2019-20 thus obviating any fears of food security.
- India has reaped tremendous returns for its investment in agricultural research. Expansion of agricultural technology has been instrumental in achieving higher growth and poverty reduction in India, achieving lower food prices for its vast population, improved nutritional outcomes, expansion of rural employment, agricultural exports, and enhanced level of foreign exchange earnings through improved competitiveness of our agricultural commodities in the world markets.
- High levels of research and development can lead to higher productivity, and therefore, improved economic performance. Every rupee spent on agricultural research and development yields better returns compared to fertiliser subsidy, power subsidy, education or on roads.

### Agricultural Research Structure in India:

- The Famine Commission Report (released in 1880) was an important step for laying the foundation of agricultural research structure in India. The Imperial (now India) Agricultural Research Institute was established at Pusa, Bihar. On the recommendation of the Royal Commission on Agriculture (1928), the Imperial Council of Agricultural Research (ICAR) was established in 1929 which was renamed as Indian Council of Agricultural Research (ICAR) after independence.

- India presently has one of the largest agricultural research systems in the world. The present system comprises essentially two main streams, viz. the ICAR at the national level and the Agricultural Universities at the state level.
- The agricultural research and education system in India comprises multiple institutions, including over 70 Agricultural Universities.
  - Indian agricultural research system comprises Indian Council of Agricultural Research (ICAR) institutes, Central and State Agricultural Universities (SAUs) and Krishi Vigyan Kendras (KVKs), CGIAR institutes, corporate/private research facilities.
  - NABARD also conducts and supports research.
    - Realising the importance of research and development for organisation as well as societal development, [NABARD](#) has established the Research and Development (R&D) Fund in accordance with the provisions of the NABARD Act 1981, with a corpus of Rs 50 crore replenished annually.
- The extension system has evolved with the main responsibility lying with the state KVKs that 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 technology dissemination activities at the district level by involving key stakeholders such as line departments, research organisations, non-governmental organisations (NGOs), etc.

### **Agricultural Research and Development policy:**

- Indian Agriculture Research and Development (R&D) policy has largely relied on public funding and provision, dissemination of R&D services through the Central Government and State Government extension instrumentation.
- The Indian R&D system in agriculture witnessed rapid growth from the 1980s due to liberalised policies governing investments in agri-based R&D. Tax exemptions on R&D expenditure and venture capital, rebate and relaxation for import of equipment for domestic research have attracted private participation and public-private partnerships.
- Now, more than 50 percent of agri-inputs in India are supplied by private players – be it pesticides, agro-machinery, hybrid seeds, biotechnology, fertilisers, animal seeds, etc. The R&D policy shift too has witnessed enhanced public-private partnership in R&D when public funds were allocated to private organisations through government-sponsored research projects, externally aided projects of the World Bank and through collaborative bilateral research arrangements with agriculturally developed nations.

### **Way forward:**

- It is important to incorporate the following aspects in agricultural research:

### **Higher Agricultural Research Spending:**

- The expenditure on agricultural research as a percentage of agriculture-GDP has been low at around 0.40 percent during 2012-14.

### **Focus on Crop and Non-crop Sector:**

- Research on the crop sector is still relevant for a country like India with a vast and increasing population given that the national food security faces many challenges in the coming decades such as those of climate change. However, the non-crop sector too needs emphasis since it is expected to be the pillar of future growth of the agricultural sector.

### **Focus on Small Holders and Women:**

- Two noteworthy trends in Indian agriculture have been the prevalence of smallholders (86 percent of total farmers having 47.3 percent of landholding, as per Agriculture Census 2015-16) and increasing feminisation of agricultural sector with 73.6 percent of rural women workers being farmers with 12.6 percent of landholdings.

#### **Private Sector for Research-Extension:**

- Collaborating with the private sector is essential to undertake agricultural research and taking the same from lab to the field. There is the requirement to develop low-cost technologies that may be taken to the farms by agri-entrepreneurs, thereby allowing greater participation of the private sector in research-extension.

#### **Multi-stakeholder approach:**

- There is a need for the multi-stakeholder approach in generating and sharing knowledge, including traditional knowledge, for addressing production constraints and harnessing growth opportunities in agriculture.

#### **Supportive policy structure:**

- The focus of the research policy should remain on improving the efficiency of the public research system and encouraging participation of the private sector wherever possible. The barriers to technology transfer from labs to land should be removed to stimulate technology transfer and growth.



## Chapter 3: Agricultural Research for Food Security and Income

### Background:

#### **Challenge of food security:**

- With the increasing population and diversifying dietary demand in developing economies like ours, the demand for food and other related commodities has been increasing steadily.
- The population of our country is expected to reach 1.531 billion by 2030-31. To feed this population and another 40 percent additional for seed, feed, wastage and industrial uses, the projected foodgrains demand is at 326 to 350 million tons depending upon the various approaches of estimates. These have to be achieved with declining per capita availability of land, water and other finite natural resources. The climate change effects are looming large on the entire agri-food system.
- The three important facets of food security include - availability, access and affordability.

#### **Farmer income issue:**

- Challenges like climate change, decreasing productivity of agricultural lands, increasing pest resistance to pesticides, newer plant diseases threaten to disrupt the already fragile agricultural sector and consequently the lives of the farmers dependant on the sector.
- Farmers in India receive a substantially low share of the agricultural product value, i.e, the price discovery for farmers is low. This could be attributed to factors such as low shelf life of the product apart from the challenges and risks discussed earlier.
- These circumstances have led to acute agrarian distress.

### History of agricultural research in India:

#### **Pre-Independence Agricultural Research:**

- The process of the development of the agricultural research system in India started as early as in 1869, when Lord Mayo, Governor-General in India, prepared to create the Department of Agriculture in the Government of India with counterparts in the provinces.
- During the time of Lord Curzon, in 1905, the Imperial Agricultural Research Institute was established at Pusa, Bihar. The Royal Commission on Agriculture in 1926 proposed an Imperial Council of Agricultural Research (ICAR) to promote, guide and coordinate agricultural research throughout India. ICAR was registered as a society under the Registration of Societies Act, 1860 in July 1929.

#### **Post-Independence Agricultural Research:**

- Rainfed agriculture dominated independent India. Initial emphasis was on research of rain-fed crops like cotton, oilseeds and millets.
- Inter-institutional research on rice for improving the production, productivity and profitability has also been a critical focus area for agricultural research and development.
- While new varieties and hybrids were vital revolutions in plant types, they brought new challenges in soil and water management. To provide scientific solutions for moisture conservation, crop production, selections of varieties, crops and cropping systems, crop substitution, alternate land use, etc., the AICRP on Dryland Agriculture (AICRPDA) was initiated in 1987. Ex-situ rainwater management, integrated nutrient management, crop diversification, alternate land use, integrated farming systems, strategies for climate variability, etc. were the thrust areas.
- Livestock and fisheries research was also carried out simultaneously to develop new breeds, quality standards, strains and fingerlings, health and hygiene, etc.

- The frontline extension system in India started with the first Krishi Vigyan Kendra (KVK) established in Puducherry in 1974. At present, each district in India has one KVK, many big districts are having 2 KVKs.
- The State Agriculture University (SAU) plays complimentary responsibility for location-specific agricultural research.

### **Research for Food Security:**

- After two successive severe droughts in 1964/65 and 1965/66, India needed American wheat under PL 480 at relatively low prices and on rupee payment due to lack of foreign exchange to buy food in the world market. Norman Ernest Borlaug's new semi-dwarf, disease-resistant varieties, revolutionised spring wheat in Mexico making Mexico fully self-sufficient in wheat production and net exporter in 1963. This variety was successfully adopted in India giving rise to the [Green Revolution](#) in India.
- Post Green Revolution, the [White Revolution](#) happened in the country which augmented milk production. Research in cross-bred breeds and their feeding and shelter management helped sustain the growth in milk production. The research in small ruminants, poultry and fisheries for breeding, feed and nutrition, disease management helped these sectors grow by leaps and bounds. The diagnostics and vaccines developed after concerted research have helped not only control the diseases but also eradicated some of the dreaded diseases from the country such as Rinderpest, Contagious bovine pleuro-pneumonia, African house sickness and Dourine – a parasitic disease. The country is poised to be FMD Mukht by 2030.
- In 1986, the Government introduced Technology Mission on Oilseeds (TMO) to enhance the oilseeds production through technological interventions and area expansion. Later, pulses were included under TMO to make it TMOP. The new HYVs in soybean, R&M, groundnut and other oilseeds with concerted efforts on the seed development and promotion could transform the oilseeds production within 10 years. The significant increase in pulse productivity, due to the introduction of new varieties in the seed system, has helped the country attain near self-sufficiency in pulses production. This is a good example of research contributing to the food security of the nation and also import substitution.
- The development of new varieties with multiple resistances for diseases and abiotic stresses in horticultural crops could boost the production surpassing the foodgrains production in the country. Recent advances in basmati rice, multiple disease resistance in wheat, tomato, rice, etc. along with genomics in pigeon pea, chickpea, rice, tomato, etc. are some examples.

### **Conclusion:**

- The agriculture research has been the saviour for addressing the food security, income to farmers and those who work on the farms and other related activities and on a larger note to the sustainability of the natural resources for the very sustenance of mankind.
- The pursuit of making India Aatmanirbhar should continue with concerted efforts in agricultural research for developing new varieties, production and protection technologies and quality and safety standards for the Indian products. There is a need to invest in the R&D for infrastructure and human resources development to make India globally competitive and sustain the food and nutritional security for all and income to farmers and rural workers.

## Chapter 4: Research and Development for Sustainable Agriculture

### **Background:**

- India has become one of the world's largest producers of food grains, spices, milk, etc. Though this has helped ensure food security to India, the progress remains prone to disruptions given the unsustainability attached with the methods employed thus far.
- Farming in India is a complex and high-risk business in the wake of climate change, water scarcity and land degradation. The emerging issues for sustainable agricultural development include growing population pressure on land, resource degradation and water scarcity, impacts of rapid urbanisation, increasing pressure on diminishing natural resources, low level of investment in agriculture R&D, etc.
- The agriculture sector's future depends on how sustainable and climate-smart agriculture practices are, and how the country prepares itself for adopting improved agriculture practices, climate-resilient varieties and technologies through enhanced research and development interventions.

### **Sustainable Agriculture Process:**

- Sustainability of agriculture stands on three pillars viz. economic, environment and social development.
- This would involve making the agricultural process economically viable and ensure social development for all the stakeholders while also ensuring the environmental sustainability of the processes and technologies involved.
- This would involve aspects such as reducing wastage by improving shelf-lives of agri-produce, addressing issues like land degradation, environmental degradation, population growth and resultant resource scarcity in the rural farm scene.
- Innovative agriculture practices should help in maximising the profit, reducing wastes and ensure social impact focusing on livelihood and rural employment. Agriculture should also generate new opportunities for employment through research in different sectors.

### **Agriculture Inputs:**

- The transition of the country from the stage of food scarcity to food surplus has been possible only because of continuous emphasis on R&D in the agriculture input sector.

### **Seed:**

- Production of breeder, foundation and certified seeds resulted in sustaining the agriculture. Indian Council of Agricultural Research (ICAR) developed various drought resistant and hybrid seeds to sustain and improve agriculture.
- Various rules/regulations and statutes viz. Seed Act (1966), Seed Control Order (1983), Seed Rules (1968), and National Seeds Policy (2002) have helped in strengthening the seed industry. Genetic manipulation of crops has resulted in increasing the yield of crops too.

### **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.
- Emphasis on production of bio-fertilisers and promotion of chemical-free cultivation has increased the area under organic farming. As of March 2020, about 1.8 percent of the total cultivable area (27.7 lakh hectare) has been covered under organic cultivation in the country.



- Nanofertilisers, a recently launched product, have immense potential for ensuring soil health through efficient management of fertility for improved crop production.

### **Agro Chemicals:**

- R&D has resulted in the 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:**

- Production and use of different and innovative agri-equipment like tractors, balers, combines, plows, power tillers, mowers, harvesters, planters and sprayers, etc.

### **Irrigation:**

- Focusing on new and innovative irrigation and fertigation techniques.

### **Smart Agriculture:**

- Smart agriculture promotes sustainable 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 the Internet of Things (IoT) and Information Communication Technology. Big data analytics, predictive analytics, cloud computing, machine learning and artificial intelligence can bring in a revolution in the efficient use of agri-inputs so as to make agriculture sustainable and profitable.

### **Farm Management Information System:**

- Farm Management Information System (FMIS) provides information at a given period instantly which inter alia, includes data on soil sample, weather conditions, sensor data, maps, etc.
- Analysis of such information is necessary to arrive at right farming decisions at an appropriate time.

### **Geographical Information System:**

- The Geographical Information System examines and analyses the wider range of agricultural-related resources such as soil, weather, hydrology i.e. irrigation pattern and various socio-economic variables which are important parameters of crop productivity.

### **Nanotechnology:**

- Nanotechnology has prospects for integrated pest and nutrient management.

### **Artificial intelligence:**

- Artificial Intelligence helps in capturing images and identifying pests and plant diseases for better agricultural administration at field level.

### **Machine Learning and IoT:**

- Machine Learning algorithms provide for digital mapping of crop health and ground-level moisture.

- IoT for agriculture has a built-in mechanism for monitoring crop fields with the help of sensors and automating the agriculture practices.

**Drone technology:**

- Drones can perform several significant tasks like the application of fertiliser, pesticides, crop monitoring, crop estimation and damage assessments.
- Low levels of technology penetration, small farm size and shortages of qualified workers at the rural areas have remained the major limiting factor for use of drones.

**Clean and Green Agriculture:**

- Significant losses from fruits and vegetable processing industries have become a serious concern for the pillars of Sustainable Agriculture. Such wastes have an adverse effect on the environment.
- Agricultural research has paved the way for reuse, reduction and recycling of agriculture by-products and wastes for sustaining the environment and social aspects.

**Conclusion:**

- Natural resource management, input use efficiency, building climate resilience in agriculture and transformation of farmers through technological interventions are important guiding lights for the agricultural sector going forward.
- 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 inputs.

## Chapter 5: Strategies to Boost India's Global Agriculture Trade

### Agricultural trade of India:

- Agriculture accounts for 11 percent of India's trade with the rest of the world.
  - In 2018, agriculture accounted for 10 percent of global merchandise trade which stood at US\$ 19.67 trillion.
- India is the eighth largest exporter of agricultural produce.
- India's agriculture is an important constituent of the global agricultural value chain.
- In 2019-20, while agricultural exports from India were US\$ 33.9 billion, i.e. 10.8 percent of India's total merchandise exports, agricultural imports stood at US\$19.9 billion, accounting for 4.2 percent of total merchandise imports. While agricultural exports dipped by 7.4 percent, agricultural imports hiked up by ten percent in 2019-20.
- Agricultural exports include both food and non-food products.
- Cereals constituted about 20 percent of India's agricultural exports. As far as imports are concerned, close to 50 percent of India's agricultural imports are accounted for by animal or vegetable fats and oils.

### Significance of agriculture trade:

- While economic growth leads to trade, trade has been ascribed as an engine of growth. There are substantial benefits of trading by practising division of labour and adopting specialisation in areas with comparative advantages.
- Improving agricultural exports could help tap the potential of Indian agriculture and help put the Indian economy back on track in the post-pandemic phase.

### Challenges:

#### **Impact of the pandemic:**

- 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. The demand side has also been constrained globally.
  - The [World Trade Organisation \(WTO\)](https://www.wto.org/) has forecasted that in 2020, global trade will plunge between 13 percent and 32 percent due to the ongoing pandemic.

#### **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.

#### *Tariff Barriers:*

- A large number of developed countries protect their agricultural sector by imposing high rates of tariffs.

#### *Non-Tariff Barriers:*

- Non-tariff barriers to trade may take the form of requirements of certification, registration, testing, packaging, labelling, licensing, prohibition, restrictions, etc.



- Over the years, developed countries have moved from tariffs to non-tariff barriers. Therefore despite having low tariffs, developed countries offer low market access to exporters, which signifies that the full potential of India's agricultural exports to developed countries has not yet been tapped.
- Specifications on slaughterhouses put in place by certain countries make exports of meat from India difficult to these countries. Some countries have banned the import of Indian meat because of reports of foot and mouth disease from some parts of the country.

#### **Lack of diversification of products and markets:**

- The top five agricultural commodities which were exported from India in 2019-20 accounted for almost 60 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 also to tap potential newer markets.

#### **WTO regulations:**

- WTO has set the subsidy limit at 10 percent of the total value of food production for developing countries. There have been negotiations which are going on for ending subsidies for illegal, unreported and unregulated fishing.

#### **Way Forward:**

- For an effective implementation of a strategy for boosting agricultural exports from India, the following measures may be considered.

#### **Logistics and infrastructure:**

- There is a need for strong logistic support entailing pre- end post-harvest facilities and storage to augment the performance of agriculture trade.

#### **New Products, New Markets:**

- As a long term strategy, new products for exports and new destinations should be explored. The choice of new products needs to be prudent keeping in view the environmental sustainability. A move towards expecting higher value produce and hitherto untapped ones, like horticulture, would undoubtedly ensure more foreign exchange.

#### **Focus on agricultural research:**

- Less than 1 percent of India's agricultural gross domestic product is spent on agricultural research. A pragmatic usage of technology can help in overcoming hurdles in agri trade.

#### **Trade Agreements:**

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

#### **Trade Facilitation:**

- It is imperative to make the farmers aware of the non-tariff barriers in the destination countries. A helpdesk, in the form of a toll-free phone number and an e-mail, may be useful to provide

information on non-tariff barriers in destination markets. Apart from reaching out to the farmers, it is also important to have their inputs/views prior to any trade negotiations.

- 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.

### **Governmental measures:**

- India's Agriculture Export Policy, released in December 2018, stresses on 'agriculture export oriented production'.
- In its report, the [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.
- There are specific bodies including Agricultural and Processed Food Products Export Development Authority and Marine Products Export Development Authority, besides statutory commodity boards like Coffee Board, Rubber Board, Spices Board, Tea Board and Tobacco Board which inter alia specifically promote exports of agricultural commodities.
- The Government 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. These would ensure affirmative steps towards mitigating farmers' accessibility issues with respect to agriculture trade.
- The increasing impetus being given to Farmer's Producer Organisations will go a long way in collectivizing the strengths of small farmers to specialize in export-oriented products by efficiently utilising economies of scale.
- A recently approved scheme of the Government of India called Remission of Duties and Taxes on Exported Products is WTO-compliant. By reimbursing eaves/duties/levies at the central, state and local levels, the scheme will provide a level playing field to Indian exporters.

## Chapter 6: Strengthening Human Resources in Agri-Supply Chain

### Introduction:

- Agri-business for India is the most significant sector of the economy both from the perspective of inclusive growth and from national and global development perspectives of addressing the challenges of food and livelihoods, energy and environmental security.
- Being the single largest employer in the country, agriculture involves approximately 60 percent of the Indian population and contributes about 18 percent to India's GDP and export earnings too. This necessitates the need to take the quality of human resources in agriculture, especially in areas like agri supply chain to the next level.

### Supply Chain Management:

- The term Supply Chain can be defined as a process where all members of the value chain i.e., the customers, vendors and all third party logistics service providers are interrelated and integrated.
- Today, the agri-food supply chain covers the entire gamut of activities from production on the farm to processing, distribution, and retailing.

### Significance:

- In a supply chain, the goods and the information are made available at the most suitable time. This helps ensure a superior value to all the concerned stakeholders.
- The stakeholders are linked and interconnected by virtue of shared information and reciprocal scheduling, product quality assurances and transaction volume commitments.
- Supply chains also ensure that farmers have real-time access to market information and even technology, another critical component for improving the services.
- Other benefits of an efficient supply chain include environmental development, more employment opportunities and significant decline in product losses which constitute some critical issues in the agricultural sector.
- Since the nature of agricultural produce is highly perishable and erratic in supply because of its seasonality and other stresses, it calls for innovative supply chain management (SCM).

### Issues:

- Supply chain management has not been up to the expected levels. The supply chain is many a time too long due to the presence of many intermediaries creating long gaps between the consumers and the producers, as a result, the farmers or the producers are unaware about the demand-side scenario.
- The existence of a substantial number of other players results in them pocketing a major proportion of the remuneration thus resulting in concomitant price escalation while depriving the producers (farmers) of the proportionate price discovery. For example, producers of agro products are getting merely 30-33 percent of the market price in most of the cases due to supply chain issues.
- Annual wastage of agricultural output is also very high mainly attributable to inadequate supply chain infrastructure.

### Recent developments:

#### **Private sector:**

- There has been an increase in private investment in the food retail sector. The emergence of supermarkets has led to changes in the retailing model of fresh produce and the management of the supply chain.

**Government measures:***eNAM:*

- The government has taken several initiatives at the national level in the recent past. The National Agriculture Market (e-NAM), a pan India unified electronic portal has been set up where farmers can directly sell their produce. It connects all the markets formed under the Agriculture Produce Committee (APMC).

*Recent farm reforms:*

- With the recently implemented changes in contract and marketing laws, shorter and more direct supply chains with traceability are expected to become more common.

**Way forward:**

- The improvement of the agricultural supply chains should be based on the following aspects.

**Digital and analytics:**

- Precision farming including integrating field data and the use of weather forecasts, apart from helping drive agronomic advice to farmers, also help in yield forecasting.
- Centralised platforms integrating farmers and wholesale markets help provide timely information for price realisation.

**Establishing market linkages between farmers and buyers:**

- This will establish transparency in pricing and better value, especially for perishable products. It could also help to increase farmer incomes by at least 8 to 10 percent.

**Investing in cold-storage:**

- The investment in cold storage infrastructure is expected to enjoy significant growth on the back of rising food demand, supply deficits and improved market economics.

**Agriculture education:****Significance:**

- Estimates suggest that by the year 2020, more than 16,000 scientific manpower would be required to cater to the needs of R&D in the country. At present, there is a substantial gap of 50 percent or more between the demand and supply of manpower in the agriculture and allied sciences sector. Hence there is the need to focus on agricultural education.
- There should be measures taken to strengthen and streamline the higher agricultural education system to enhance the quality of human resources in the agri-supply chain to meet future challenges in the agriculture sector in the country.

**Specialized education:**

- The days when agricultural education focused on academic disciplines related to improving on-farm productivity are nearly over as it today stretches beyond the farm to encompass many entities that



operate at different links in the production, processing and distribution chain of foods and agri-products.

**Measures to be taken:**

- The approach needs to be multipronged, addressing the issues of competence enhancement of the students, attracting talented youth to agriculture education, devising relevant curriculum and improving delivery mechanism.
- There should be measures to improve the quality of postgraduate research while ensuring the relevance of agricultural education to the actual demands.
- There should also be an emphasis on promoting entrepreneurship skills to enable graduates to take up their own enterprises as job providers rather than job-seekers.
- There should be improvements in the overall infrastructure in terms of student and faculty amenities pertaining to teaching and learning. This necessitates higher investments.

## Chapter 7: Innovative Practices for Smart Agriculture

### Background:

- The world's population is expecting a one-third increase from now to 2050 and most of these additional two billion people will live in developing countries like India. The [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 animal feed.
- Agriculture must therefore transform itself to feed a burgeoning global population and provide the basis for economic growth and poverty reduction. However, this transformation must be accomplished without depletion of the natural resource base.
- Climate change will continue to make this task more difficult due to adverse impacts on agriculture. To achieve food security and agricultural development goals, adaptation to climate change and lower emission of greenhouse gases ([GHG](#)) are of utmost necessity.

### Climate-smart agriculture:

- FAO has defined climate-smart agriculture (CSA) on the basis of the following three dimensions of sustainable development (economic, social and environmental) which jointly address food security and climate challenges. These three main pillars are as follows:
  - Sustainably increasing agricultural productivity and income;
  - Adapting and building resilience to climate change;
  - Reducing and/or removing greenhouse gases emissions where possible.
- Smart or precision agriculture involves applying inputs (what is needed) when and where it is needed. This has become the third wave of the modern agriculture revolution (the first was mechanisation and the second, the green revolution with its genetic modification).

### Significance:

- The agricultural production systems aim to become more efficient and resilient at the farm level.
  - This would involve measures that promote resource conservation and more efficient use of input resources. This would involve using less land, water and inputs to produce more food sustainably. The resource-conserving technologies (RCTs) and innovative practices aim precision in inputs application like seeds, fertilisers, pesticides, irrigation, etc. at farm level with Information Communication Technologies (ICTs) and decision support systems (DSS).
  - The production systems should also become more resilient to changes and shocks.

### Innovative Practices:

#### **Fertilizer management:**

- Several systems are available for fertiliser management. With the introduction of geographic information systems (GIS), global positioning systems (GPS) and remote sensing (RS), farmers can now refine nutrient recommendation to the site-specific conditions of each field. The approach of site-specific nutrient management (SSNM) is the solution to manage special variability of nutrients and better nutrient use efficiency.
- Smart fertilisers are new types of fertilisers which are formulated based on micro-organisms and nano-materials. The emphasis on controlled- and/or carrier/delivery systems will synchronise nutrient availability with the plant demands thereby reducing nutrient losses.
- Urea Deep Placement (UDP) technique, developed by the International Fertiliser Development Center (IFDC), is a good example of a climate-smart solution for rice systems. The usual technique for applying urea, the main nitrogen fertiliser for rice, is through a broadcast application which is a

very inefficient practice, with 60-70 percent nitrogen losses, contributing to GHG emissions and water pollution. Urea Deep Placement technique involves providing the fertilizer at the root zone.

- Nutrient Expert is the recently developed precision nutrient management technology guided by decision-support system software for improving crop yields, environmental-quality and overall agricultural sustainability.

### **Water Management:**

- Three major challenges vis-a-vis water management in the Indian agricultural sector involve the following:
  - “More crop per drop of water” by efficient and productive use of available water resources in irrigated areas.
  - Increased productivity of sub-productive challenged ecosystems. i.e rainfed and waterlogged areas.
  - Making use of grey water (wastewater) for agriculture production.
- Automation of Irrigation System: Pressurised irrigation systems like sprinkler, drip and subsurface drip irrigation are already prevalent irrigation methods that allow farmers to control when and how much water their crops receive. Pairing these irrigation systems with increasingly sophisticated Internet of Things (IoT) - enabled sensors would allow continuous monitoring of moisture levels and plant health.
- Deficit Irrigation Supplies: Under limited water availability conditions, irrigation strategies based on meeting the partial crop water requirements should be adopted for more effective and rational use of water.

### **Weed and Pest Management:**

- New Generation Herbicides: New generation herbicides are available in the market with the assurance of selective effective control of weeds in field crops.
- 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.
- Artificial Intelligence enabled automation in weed management can help in timely and lower cost for weed management.

### **Seed Sowing and Planting:**

- Laser Land Levelling: Precision land levelling helps in obtaining a perfectly levelled field. Benefits like better crop establishment, nutrient use efficiency, uniform irrigation have been reported with laser land levelling.

### **Environmentally sustainable practices:**

- Conservation agriculture
- Integrated farming system
- Organic farming
- Zero Based Natural farming

## Chapter 8: Sustainable Crop Production

### **Background:**

- Though the Green Revolution ensured higher production and helped achieve self-sufficiency in food production, it has been criticized for being unsustainable.
- Practices like overuse of fertilisers and pesticides, overexploitation of groundwater for irrigation, etc. have created several ecological issues. Overuse of synthetic fertilisers and pesticides have led to environmental pollution, groundwater contamination and health issues, deterioration of soil structure, herbicide/pesticide resistance. This raises concerns over the sustainability of conventional input-intensive agriculture systems.
- Agricultural growth has been volatile, having an impact on farmer incomes as well as the farmer's ability to invest in agricultural activities.
- The agricultural yield is found to be lower due to several issues like decreasing sizes of agriculture, land holdings, erratic rainfall, changing climate, inadequate irrigation, imbalanced use of fertilisers resulting in loss of soil fertility, etc.

### **Sustainable agriculture:**

- Sustainable crop production refers to crop production practices that ensure high and stable yield over time, without affecting soil and ecosystem health.
- 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 viability.

### **Significance:**

- Sustainable agriculture contributes to food security in a manner that is environmentally, economically and socially responsible over time.
- Sustainable agriculture ensures that natural resources are conserved and the agricultural land remains productive over time.

### **Important sustainable production practices:**

#### **Soil Health Management:**

##### *Issues:*

- The disparity in the prices of urea and P and K fertilisers led to a distortion in the consumption pattern of NPK fertilisers leading to a mismatch in fertilizer need and use. Repeated use of fertilizers has destroyed the naturally occurring biome in the soil thus having a negative impact on the soil fertility.
- Soil health is crucial for agriculture as a healthy soil acts as a dynamic living system delivering multiple ecosystem services.

##### *Measures needed:*

- Restoration of depleted soil nutrients and microorganisms by maintaining organic carbon content in soil is necessary for soil health.
- Growing legumes as green manuring crops or cover crops (sunhemp, cowpea, sweet clover, lentil, etc.) is a time tested technique to improve the fertility of the soil. It also protects soil from erosion by keeping the soil covered as well as adds organic matter, fixes nitrogen and improves soil structure.



- Integrated Nutrient Management (INM) 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.
- Organic Sources: Farm Yard Manure (FYM) compost, sewage, sludge, crop residues, etc. can be used as organic sources of nutrients.
- Biological Sources: Biofertilizers can be used as a source of nutrients. They can supply nutrients either by fixing nitrogen from the atmosphere or by improving the availability of soil nutrients through solubilisation and mobilisation.

### **Conservation Agriculture:**

- According to FAO (2017), conservation agriculture is a farming system that promotes minimum soil disturbance (i.e. no tillage), maintenance of a permanent soil cover and diversification of plant species (crop diversification or sensible crop rotation).
- Conservation agriculture addresses several challenges like increasing soil carbon storage and decreasing greenhouse gas emission promoting sustainable agriculture, preserving the environment and natural resources (soil, water, air) and conservation of biodiversity.

### **Crop Residue Management:**

#### *Issue:*

- The problem of residue management has gained attention in recent times as the problem of [stubble burning](#) has resulted in high levels of air pollution. Burning of crop residues also destroys a huge amount of nutrients from the soil.

#### *Measures needed:*

- In situ management of crop residue can be done through conservation agriculture practice.
- Alternate beneficial uses of crop residue include compost production, bioenergy production (through gasification or bio-oil production), biochar production, in the pulp and paper industry.

### **Integrated Pest Management:**

- Integrated pest management (IPM) involves careful consideration of all available pest control techniques and subsequent integration of appropriate measures. IPM considers all available control options such as cultural, physical, chemical and biological methods to control pests.
- It controls the development of pest populations and keeps pesticide usage to levels that are economically justified and thus help reduce or minimise risks to human health and the environment. IPM also helps delay the risk of pesticide resistance development. In addition to ecological benefits, IPM can also give economic benefit as the cost of pest control is reduced in this approach.

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

- Inclusion of legumes in the cropping system can be helpful in improving soil fertility and making the production system sustainable. Legumes add nitrogen to the soil through nitrogen fixation, improve phosphorus availability through rhizosphere modification and help in nutrient cycling by bringing the subsoil nutrient to the top soil through its deep root system.
- Legumes can also be used as green manuring crops. Legumes are close growing and have a dense canopy. This is the reason that legumes serve as cover crops.
- Legumes grown as intercrop can improve productivity as well as soil fertility. Legumes, because of their fast-growing habit and dense canopy, can suppress weed effectively.

### **Climate-Smart Agriculture:**

- Climate-Smart Agriculture (CSA) is an approach for developing strategies to secure sustainable food security under changing climate scenarios. Climate-smart agriculture has three main pillars i.e. sustainably increasing agricultural productivity and income, adapting and building resilience to climate change and reducing and/or removing greenhouse gas emissions to a safe level.
- To meet the challenge of climate change on the sustainability of Indian agriculture, the Indian Council of Agricultural Research (ICAR) has launched National Innovations on Climate Resilient Agriculture (NICRA) that has been evolving climate-resilient agricultural technologies.

### **Resource Conserving Technologies:**

- Injudicious or overuse of resources not only adds unnecessary cost to the production process but also negatively affects the environment. Resource conserving technologies (RCTs) can help achieve higher productivity in resource-poor areas.
- Use of hydrogel (a water-absorbing material) in dryland or limited water conditions can improve water use efficiency.
- Use of GIS and GPS for precise agricultural input management (precision farming) can also be considered as a resource-conserving technology.

### **Government initiatives:**

- Multiple initiatives that have been taken up by the Government of India to promote sustainable agriculture practices:
  - National Mission on Sustainable Agriculture (NMSA)
  - [Paramparagat Krishi Vikas Yojana \(PKVY\)](#) aims at the development of sustainable models of organic farming.
  - [Pradhan Mantri Krishi Sinchayee Yojana \(PMKSY\)](#) seeks to extend the coverage of irrigation with improved access to irrigation and water use efficiency.
  - Soil Health Card Scheme is aimed at improving soil fertility on a sustainable basis. The Soil Health Card scheme gives each farmer soil nutrient status of his holding and advises him/her regarding the dose of fertiliser application and need of amendment to realise optimal yield and maintain soil health in the long run. This initiative is a step towards sustainable soil fertility management by promoting a balanced use of fertilisers to enable farmers to realise higher yields at a lower cost.

### **Conclusion:**

Sustainable crop production practices must be promoted among farmers. As some sustainable crop production practices may require high initial cost, financial assistance may be given to farmers.

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