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Role of Research and Development (R&D) in Indian Agriculture

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Abstract

Indian agriculture has been transformed remarkably over the last few decades in reality. Multiple factors such as growth in household income, expansion in food processing, and increase in agricultural exports has facilitated double digit growth to this section. The green revolution is considered to be a significant technological breakthrough that generated a long lasting influence on agriculture in India. However, when it comes to investments in Research and Development, Infrastructure and Technology implementation, a lot more need to be done. With ever increasing supply side constraints, the role of R&D has become increasingly important with the potential to offer long term solutions for Indian agriculture. Farmers' access to latest researches can help in overcoming issues like seed, pests and diseases problems; crop sustainability; climate change; irrigation problems; soil erosion etc. Earlier, research institutions, agricultural universities, and public sector corporations were important stakeholders in the R&D ecosystem for sustainable agricultural practices.

Introduction

Agriculture and allied sectors are the backbone of Indian economy accounting for approximately 14% of GDP and 50% of its entire workforce is involved in these activities. About 48% of the population is dependent upon it and more than 65% of the citizens are living in rural India. Agriculture is the source of food, feed, fibre, fuel, fodder, timber, fruits, flowers, and medicinal products etc. significantly contributing to livelihood of Indian people. Increasing agricultural productivity is the key challenge for realizing higher output and farmers' income. The green revolution endowed India with a greater genetic diversity and was supported by enhanced institutional capacity which led to produce more crops. The cultivation of high yielding varieties, improved irrigation infrastructure, greater input flow through chemical fertilizers and pesticides, farm mechanization, credit facilities, buttressed by price support, and other rural infrastructure facilities ushered in the green revolution. It introduced new technologies and policies in developing countries with assistance from the industrialized nations between 1940's and 1960's to increase production and productivity of food crops (Conway, 1997 and Dalrymple, 1979). It stimulated infrastructure and rural development, increased prosperity of villages, and improved the quality of life. The radical change in land use and agricultural production transcended India from a food importing country to a self-sufficient and thereafter even to a food exporting nation. There is lot of improvement in the context of agricultural production and productivity in India after green revolution.

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Research Strategies for Irrigated Ecosystems

• The irrigated area in the country is about 65.7 million ha which contributes approximately 47% of the net cultivated area of 141 m ha.

• Only about 26 million ha is under irrigated double cropping.

• The primary objective should be the enhancement of irrigated areas under double cropping system.

• A better water management for every farm enterprise with its assured source of irrigation lays the foundation for a more secure production system at the farmer's level.

• Per capita availability of water has been steadily declining due to increase in population, rapid industrialization, urbanization, cropping intensity and declining groundwater table.

• There is a wide gap between irrigation potential created and its utilisation which needs to be bridged through use of potential technologies such as adopting water use efficient varieties, cropping system, micro irrigation, sensors and proper crop alignment etc.

Research Strategies for Rainfed Ecosystems

• There is an urgent need to understand and mitigate the terrible impacts of drought, land degradation and poverty for improving livelihoods at individual farmer's level and for ensuring food security at national level.

• Management of natural resources by adopting science driven, holistic and sustainable development approach is mandatory.

• In India, rainfed agriculture constitutes 53% of the net cultivated area and is the hot spot of poverty and malnutrition.

• Rainfed areas have been bypassed by the desired package of interventions benefitted from green revolution technology.

• It was understood by the researchers and policy makers that the significance of rainfed agriculture should be taken into consideration to fulfil the requirements of food which would proceed to increase with the burgeoning population pressure anticipated to cross over approximately 1.6 billion by 2050.

• It is essential to enhance land productivity of such vast tracts of the country's arable land.

• There is vast untapped potential in rainfed areas, and with appropriate soil and water conservation practices higher productivity, on-farm jobs and incomes can be obtained.

• Evolution and promotion of crop diversification.

• Develop crop genotypes with high and stable yields coupled with abiotic and biotic stress tolerance.

• Location specific soil and water conservation measures.

• Alternate land use systems like agro-forestry.

• Participatory research approach.

• Increasing resource use efficiency for enhancing system productivity is pivotal for increasing and sustaining productivity levels.

• For sustainable livelihoods, current extension system promoting commodity based technologies needs to be reoriented towards system based approach.

Research Strategies for Hill Agriculture

• Agricultural growth can be accelerated through diversification from low to high value crops.

• Separate hill agricultural policies need to be formulated.

• Market driven production and market led extension systems are lacking in the developmental programs of hill states.

• A gap exists in construction of basic infrastructure coupled with institutional support.

• Hill areas need expansion and up-scaling of watershed development and programs.

• Watershed approach would include ridge to valley based treatment of the hilly and undulating topography.

• The intervention has to be livelihood centric, so that all the inhabitants find a stake in watershed treatment and subsequent management.

• There is need for research relating to introduction of improved and adaptable varieties of crops and breeds of animals.

• Efficient management of soil, water and pests and diseases.

• Increase animal production by adopting scientific system.

• Use of hill topography specific agricultural machineries.

• Increase rural income and employment through developing high value products.

• Local opportunities for value creation are also necessary.

Research Strategies for Coastal Agriculture

• Scientific and precautionary measures are necessary to avoid possible detrimental effects.

• Agricultural plans must address issues of efficient use of land and water, new land for agriculture, and maintenance of water flows and water quality necessary to support

coastal ecosystems, as well as use of agro-chemicals and such other factors.

• Coastal agriculture has major positive, but also potentially negative effects on the coastal environment.

• The system needs sensitive approach to research and development.

• Sustainable agricultural policies are needed to minimise the negative impacts of inland agriculture on coastal areas.

• There is a need to revamp agriculture, forestry and fisheries sectors.

Strategies for Improvement of Crop Sector

• Development of improved varieties or hybrids of crops suitable for diversified agro-ecological situations is necessary.

• Efficacious, economical, environment friendly and sustainable production and protection technologies must be adopted.

• Promotion of significant excellence in fundamental or basic, strategic and anticipating research is beneficial.

• Seed production technologies should be refined and production of breeder seed with added emphasis on hybrid cultivars must be encouraged.

• There is need for conservation and sustainable use of genetic resources of plants, insects and other invertebrates, and agriculturally important micro-organisms.

• Provide knowledge intensive advisory and consultancy in crop science.

Strategies for Improvement of Seed Sector

• A more robust seed production system is necessary for increasing the ratio of certified seeds.

• The quantity of farmer saved seeds needs to be taken care of by promoting and closely monitoring the 'Seed Village Programme'.

• Seed Hubs to produce certified seeds and Seed Village Programme to promote farmer saved seeds need to be supported by new and location specific seeds and seed processing infrastructural facilities.

• This would help in maintaining the desired levels of quality and standards.

• **Low seed replacement rate (SRR):** The minimum seed replacement rate to achieve higher productivity is 25% in case of varieties of self-pollinated crops, 35% in case of varieties of cross-pollinated crops and 100% in hybrids.

• The emphasis on seed replacement advocated in India has resulted in reaching the optimum SRR in most of the food crops like wheat, paddy, maize, soybean, mustard, mung bean and other crops within a span of a decade.

• In certain crops *viz*., chickpea, sunflower, jowar etc. the minimum SRR required for better production and productivity is yet to be achieved.

• **Low varietal replacement rate (VRR):** The new varieties are generally high yielding relative to the existing varieties or are better protected through tolerance or resistance to pests and diseases or have some additional quality attributes.

• The newly released varieties can reduce the cost of production and use of pesticides.

• The better quality of newly released varieties may fetch better price and the higher yields will help in increased production and productivity.

• Along with SRR, VRR also needs due attention.

• Inclusion of location specific new varieties needs to be integrated into the seed chain.

• Lack of seed grid: At present, there is no seed grid available in India; hence, the development of seed grid will reduce the problem of quality seed availability at national level.

• Absence of cooperative system of seed production: The cooperative system of production is absent in seed sector.

• Designer seeds suitable for abiotic and biotic stresses: Development of situation specific varieties is the need of the hour.

• Various modern technologies including modern bio-tech tools like Crisper-Cas9 technology and other GM technologies, particularly in case of non-food crops varieties possessing resistance to abiotic and biotic stresses can be designed.

• In recognition of the larger concerns of bio-safety of GM based food crops, greater emphasis on using untapped genetic diversity through conventional breeding would be an option.

• New generation molecules for seed treatment: Seed treatment is an important technology which can be used successfully for various purposes, including enhancement of higher initial vigour, tolerance to pests and diseases, suitability for sowing under abiotic stress situations.

• Varietal identification through full proof technology: Use of modern tools for faster detection of varieties in short span is warranted for successful implementation of registered traded seed conception.

• Safe seed storage technologies: A series of seed storage chains should be developed under public private partnership for safe storage of seeds to meet the requirement in distress situations.

Strategies for Improvement of Natural Resource Management Sector

- Updated land resource inventory.
- Characterization and agricultural land use planning.
- Integrated water management.
- Waste water utilisation.
- Nutrient and bio-waste management.
- Management of saline, alkaline, acid and waterlogged soils.
- Soil and water conservation.
- Organic farming.
- Climate resilient agriculture.
- Abiotic stress management.
- Agro-forestry.
- Integrated farming systems.
- Arid land management.
- Solar farming.
- Conservation agriculture.
- Other resource conservation technologies.
- Nano-technology.

Conclusion

Technology integration has the potential to transform entire agribusiness value chain, from agricultural production and origination to trading. With the application of Internet of Things, mitigating risks and tracking crop from field to farm is now much easier. Agri-tech may play an important role in aiding sustainable agriculture for tomorrow. Technology and R&D are critical differentiator of the Indian agro industry, at primary (production), secondary (processing) and tertiary level. R&D generates new technologies and passes them to farmers. In the forthcoming years, agricultural methodologies are going to perform a significant responsibility to address their concerns associated with preservation and administration of natural resources. The need of the hour is to bridge the gap between research and practice. Agricultural research has greater influence in imparting food security to the nation and benefitting the farmer with better output and income. The ICAR-SAU combination contributes to the coordinated research and education system for agriculture and allied sciences in the country. The Department of Agriculture, Cooperation and Farmers Welfare (DAC&FW), under the Ministry of Agriculture and Farmers Welfare, Government of India has been playing key role in extension and agricultural development system of the country.

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