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Recent trends and advancements in agricultural research: An overview

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Abstract

Do you know the most precious thing happening in Indian Agriculture? Few keywords such as food, organic farming, climate change and improved farming techniques may strike to your mind. But the recent improvements in agriculture are way more advanced. These advancements along with the increase in urbanization are major drivers for the evolution of agricultural research. Recent trends in the area of Agricultural Research comprise of Eco-Agro-tourism, Big Data Analytics, Climate Smart Agriculture, Advanced Marketing Linkages, Integrated Farming System, etc. These trends are important not only from the research context but also from the policy point of view towards ambitious goal of doubling farmers' income by 2022. In today's era technology plays a very important role in encouraging farmers to take up entrepreneurial ventures and agro-based industries. Recent research has also spoken about combining Agriculture technology with the Information technology for improving the agricultural output. Traditional farming approach need to be replaced with the modern farming approaches like Integrated Farming System, Vertical Farming, Forward and Backward integration, etc. With the increase in population and limited resource availability, research related to Urban Agriculture is being emphasized which encourages the urban population to go for organic cultivation for healthy and safe produce. With the increase in per capita income, consumers are willing to spend more on quality products which is impacting backward linkages towards farmers to adopt good practices at production level. For mitigating the environmental challenges, research is focusing on Climate Smart Agricultural Techniques like DSR (Direct Seeded Rice) which reduces the water usage by about 50 to 60 percent and methane gas emission to a large extent ultimately helping the farmers to earn more carbon credits. In nutshell, it can be stated that along with coping up the major challenges such as climate change, boosting farmers' income and feeding the billions, above stated trends in agricultural research are seen as ray of hope for sustaining Indian agriculture.

Keywords: eco-agro-tourism, big data analytics, climate smart agriculture, advanced marketing linkages, integrated farming system, direct seeded rice

Introduction

Agriculture is the most important sector in India in terms of the population dependent on it. Although agriculture now accounts for only 14 per cent of Gross Domestic Product (GDP), it is still the main source of livelihood for the majority of the rural population. As such rapid growth of agriculture is critical for development of rural economy. A viable development of rural economy will leads to inclusive growth. Government is coming up with various sector specific schemes in agriculture keeping in view allied agricultural activities. Glimpse can be addressed with the union budget 2018 and provisions discussed for agriculture. The National Agricultural Policy (Ministry of Agriculture, 2000) of the Government of India aims at agricultural growth (4% annually to 2020) with sustainability, by a path that will be determined by three important factors: technologies, globalization, and markets. Agricultural research and education of the future must therefore address two related challenges: increasing agricultural productivity and profitability to keep pace with demand, and ensuring long-term sustainability of production.

The National Agricultural Research System (NARS) deals with the first challenge. Development of short-duration, high-yielding cultivars, irrigation, and intensive use of fertilizers and other agro-chemicals provided the technological basis for increasing agricultural production and the green revolution. Central to the adoption of green revolution technologies were the micro or farm economics- which governed the use of inputs such as land, cultivar, labour, machinery, and chemicals balanced against profits from crop yields and the macro economics that ensured better access to inputs and markets.

Agriculture today has not limited to only producers and consumers but many stakeholders are also involving in this sector and generating employment. With various challenges like urbanization, technology dissemination, food security and safety, agriculture is seen as ray of

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hope to address all these issues and overcome in order to boost the economy. Therefore, the recent trend in agriculture has been focused on organic and vertical farming not only addressing the rising concern for environmental issues but also accommodating the demands of food of increasing world population. Recent development envisages the use of DSR (Direct Seed Rate) technology among farmers which has resultant in water saving and also environment development. The excessive use of chemical fertilizer and pesticide in agriculture may lead to adverse effects in food products and in the environment. Organic farming is considered as a viable alternative in comparison to chemical-based agriculture. Various work are ongoing in this direction while some growers are shifting themselves towards natural farming also. These shifts are based accordingly to address the environment based needs and sustainability. World's biggest organic agriculture think tank 'international forum for organic agriculture movements' (IFOAM), along with research institute for organic agriculture (FiBL) had published their latest study on the World of Organic Agriculture 2018. Surpassing Mexico and Uganda, India had become world's largest country in terms of number of organic producers. India, as per the authenticate data by study for 2016 had 8,35,000 number of organic agriculture producers. This number is even higher than the total number of the other two nations in the list where Mexico has 2,10,000 and Uganda has 2,10,252 number of organic commodity producers. In other dimension if we talk about boosting, motivating and improving incomes of farmers then recent developments may be seen like agritourism, integrated farming with inclusion of allied agricultural activities. Tourists will get the advantage of learning a lot about villages, forest, food habits and farming while staying in villages. Government is making arrangements for the stay and safety of tourists in rural areas. This step has a positive impact on the farmers. Their source of income will increase since they will be providing accommodation and food. Also tourists will get an altogether different experience. Government is making agendas for developing Agri Tourism to promote tourism as well as make it an area of earning for the rural areas.

In today's era technology plays a very important role in encouraging farmers to take up entrepreneurial ventures and agro-based industries. Recent research has also spoken about combining Agriculture technology with the Information technology for improving the agricultural output. Trends are shifting towards smart farming among growers. Smart Farming is a development that emphasizes the use of information and communication technology in the cyber-physical farm management cycle. This is encompassed by the phenomenon of Big Data, massive volumes of data with a wide variety that can be captured, analysed and used for decision-making. India should look at establishing a systematic mechanism to capture the data that could offer additional value creating opportunities. In particular, rapid proliferation of mobile technologies in rural populations could let farmers in these areas to improve productivity based on decision made backed by better information grounded on Big Data.

Keeping these things in view, present study has incorporated recent developments and shifts addressing Indian agriculture while keeping in view the challenges and opportunities with said developments.

Design/methodology/approach

A narrative review of literature has conducted referring to various developments, trends and shifting areas of agricultural research keeping in view various stakeholders involved in integrated chain of said sector.

Literature reviewed and discussions

Point wise discussion of recent trends in reference to agricultural development has stated in this section.

1. Eco-Agri-tourism

Eco-Agri- tourism is the latest concept in the Indian tourism industry, which normally occurs on farms in the villages. It offers people the welcome escape from the daily hectic life in the peaceful rural environment. It provides a chance to relax and revitalize in the natural environment, surrounded by magnificent setting.

Agritourism can be defined as the act of visiting a working farm or any agricultural, horticultural or agri-business operation for the purpose of enjoyment, education or active involvement in the activities of the farm or operation.

Now-a- days the urban areas population is increasing due to increased migration village areas. The life of urban people is limited to their homes, offices, television, clubs, videogames, fast foods, mobile phones, etc. Urban people also want to enjoy rural lifestyle and they are curious to know about what agriculture is all about? How the cultivation of crops takes place, experience ploughing the land, milking the cow, want exposure allied agriculture activities like poultry, fishery, forestry, bee keeping, organic farming, terrace gardening, horticulture, floriculture, etc. The concept of Agri-Tourism which includes farmer, village and agriculture offers a good opportunity to satisfy the curiosity of urban population. Eco-Agri- Tourism concept brings urban people closer to the nature and rural activities, in which the people participate, get entertainment and feel the pleasure of tourism (Kumbhar, 2010).

Agri-tourism activity capitalises on rural culture as a tourist attraction. It provides potential income to the rural population and employment opportunities in rural areas, thereby improving the livelihood of the rural population. Moraruetal, (2016) in their research on motivations and challenges for entrepreneurs in Agritourism revealed that the most common reason for involving farmer in agritourism is the desire for supplementary income and the main challenges in the agritourism industry were dealing with visitors, marketing agritourism business and many agritourism operators lack the assistance, the knowledge and skills required to develop market-ready products. Additionally, Agritourism acts as an avenue for the direct marketing activity by the farmers to the end consumers ultimately increasing the farmers share in the consumer's rupee. Agritourism also provides educational opportunities to the urban students who get a good exposure about various agriculture related ventures.

2. Big data analytics and food security

The projected population growth and urbanisation rates will have dramatic impacts on food security across the world by 2050. The impacts are multi-sectoral and extend well beyond food into infrastructure, healthcare, and technology. At the same time, the growing demand for food and shifting food security needs are driving innovation in the resource space.

World is now more inter-connected, spawning massive data and exploration of these data can help to drive decision making that can transform the farm source-to-consumer value chain. Agri-businesses are subject to numerous regulations and consumer requirements across their supply chain. Of the several touch points along the agri-value chain, each hold critical information that can help businesses make the most of their resources, provide greater transparency in their processes and protect consumers. Big Data has the potential to add value across each touchpoints starting from selection of right agri-inputs, monitoring the soil moisture, tracking prices of markets, controlling irrigations, Indicating the right selling point and getting the right price. The challenges and opportunities of data is immense in a country like India with 638,000 villages and 130 million farmers speaking around 800 languages with 140 million hectares of cultivable land under 127 agro climatic regions capable of supporting 3,000 different crops and one million varieties. Recent progress in Big Data and advanced analytics capabilities and agri-robotics such as aerial imagery, sensors, and sophisticated local weather forecasts can truly transform the agri-scape and thus holds promise for increasing global agricultural productivity over the next few decades. Satellite imagery has the potential to capture images of farmer fields to 1 m x 1m resolution (20 – 25 pixels), which is improving further with invent of technology. These images can capture various data points such as Leaf Area Index, plant height, canopy etc which is indicative of crop vigour and hence can be used to accurately estimate farm yield.

Financing to farmers is another challenge which data can solve. The current priority sector lending to farmers stands at approx. USD 135 bn. However, majority of bankers still face the challenge of determining credit-worthiness of farmers due to lack of KYC records. Lending to farmers can become very efficient, logical and data-driven, if the bankers have access to data on likely crop output from farmer's field (which can be determined as mentioned earlier). Likewise, insurance companies can ascertain risk premium if they have access to weather, soil, pest and output data. In summary, use of data has the potential to solve most ag-supply-chain problems. Inclusion and incision of "Data" can be a game changer for Indian agriculture. In general, farmers are open to adapting technology. Farmers are downloading apps for real-time access to data such as market yard prices.

IDC estimates that the market for big data and business analytics will grow from \$150Bn in 2017 to more than 203Bn in 2020. Despite significant market potential, there is a dearth of analytical talent – data scientists (akin to the Wall Street quants of the 1990s), analysts and managers – to leverage the economic value of big data. There has been a significant trend to consider the application of Big Data techniques and methods to agriculture as a major opportunity for application of the technology stack, for investment and for the realisation of additional value within the agri-food sector (Noyes, 2014; Sun et al., 2013b; Yang, 2014). Big data applications in farming are not strictly about primary production, but play a major role in improving the efficiency of the entire supply chain and alleviating food security concerns (Chen et al., 2014; Esmeijer et al., 2015; Gilpin, 2015a). Currently, big data applications discussed in the literature are taking place primarily in Europe and North America (Faulkner and Cebul, 2014). Considering the growing attention and keen interest shown in the literature, however, the number of applications is expected to grow rapidly in other countries like China (Li et al., 2014; Liu et al., 2012). Big data is the focus of indepth,

advanced, game-changing business analytics, at a scale and speed that the old approach of copying and cleansing all of it into a data warehouse is no longer appropriate (Devlin, 2012). Opportunities for Big Data applications in agriculture include benchmarking, sensor deployment and analytics, predictive modelling, and using better models to manage crop failure risk and to boost feed efficiency in livestock production (Faulkner and Cebul, 2014; Lesser, 2014). In conclusion, Big Data is to provide predictive insights to future outcomes of farming (predictive yield model, predictive feed intake model, etc.), drive real-time operational decisions, and reinvent business processes for faster, innovative action and game-changing business models (Devlin, 2012).

3. Climate smart agriculture

Climate-smart agriculture may be defined as an approach for transforming and reorienting agricultural development under the new realities of climate change (Lipper et al. 2014). FAO (Food and Agricultural Organisation), which defines Climate smart agriculture as "agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes GHGs (mitigation) where possible, and enhances achievement of national food security and development goals".

According to FAO, Climate Smart Agriculture pursues triple objectives of sustainably increasing productivity and incomes, adapting to climate change and reducing green house gas emissions wherever possible. Majority of Indian population live in rural areas and agriculture is the main source of livelihood to them. Due to climate change many effects are observed like increase in temperature, rising sea levels, extreme weather events, etc. All of these pose risks for agriculture activity, food production and water supplies. Therefore, Resilience is predominant a concern. Agriculture is one of the sources of greenhouse gas emissions. According to World Bank Report, agriculture currently generates 19-29% of total Green House Gas emissions. Without action, that percentage could rise substantially as other sectors reduce their emissions. Researchers have developed an array of practices and technologies towards fostering promoting stability in agricultural production against the onslaught of seasonal variations. Farmers need to intelligently adopt such resilient practices and technologies. Efficiency in resource-use, sustainability and long-term development of agriculture, and environmental and social safeguards assume greater importance.

4. Direct seeded rice (DSR) technology

Increasing water scarcity and labour wages in rice are triggering the search for such alternative crop establishments which can increase the water productivity. Direct Seeded Rice (DSR) is the viable option for reducing the unproductive water flows. DSR refers to the process of establishing a rice crop from seeds sown in the field directly rather by usually transplanting seedlings from the nursery to the main field. Dhillon and Romana (2016) revealed that DSR has got the potential to improve water use efficiency, reduce other losses besides significantly reducing the methane production by producing the aerobic conditions and they mentioned that DSR saved labour worth Rs. 5250 per hectare, irrigations to the tune of 40 per cent and realized an additional yield to the tune of 2.61 percent accounting to Rs. 3298 per hectare over the normal transplanted rice. Prasad et al (2014) found out that due to use of Direct Seeded Rice (DSR) technology, saving in water was up to 25%, saving in energy (Diesel) up to 27%,

saving of 35-40 man days/ha, enhanced fertilizer use efficiency due to placement of fertilizer in the root zone, early maturity of crops by 7-10 days helps in timely sowing of succeeding crops, reduction in methane emissions and global warming potential, little disturbance to soil structure and enhanced system productivity.

5. Innovative marketing models

Agribusiness models range over different products and services delivery options and are accordingly categorized into one stop shops, popularly known as Rural Business Hubs (RBHs), or procurement led or input driven models or ICT, FPO related agribusiness models.

For new entrants, process of understanding markets and developing strategies to tap it right. Model building is a continuous process of learning and innovation that catalyzes both backward and forward linkages with the farmers. SFAC (Small Farmers Agribusiness Consortium) has developed an integrated database of 5 lakh farmers across 250 FPOs to make a match of demand and supply for inputs to start with eRBH. Markets can and should serve the poor. Empirical studies show that small holder farmers aggregating business models in Africa have resulted in 50% to 100% increase in farmer income. Parastatal as a model exists in Africa wherein the government gets into organizing chains for cash crops like Ghana Cocoa Board or Kenya Tea Development board which shows the most integrated models.

6. e-NAM

National Agriculture Market (NAM) is a pan-India electronic trading portal which networks the existing APMC *mandis* to create a unified national market for agricultural commodities. The NAM Portal provides a single window service for all APMC related information and services. This includes commodity arrivals & prices, buy & sell trade offers, provision to respond to trade offers, among other services. While material flow (agriculture produce) continues to happen through *mandis*, an online market reduces transaction costs and information asymmetry.

Agriculture marketing is administered by the States as per their agri-marketing regulations, under which, the State is divided into several market areas, each of which is administered by a separate Agricultural Produce Marketing Committee (APMC) which imposes its own marketing regulation (including fees). This fragmentation of markets, even within the State, hinders free flow of agri commodities from one market area to another and multiple handling of agri-produce and multiple levels of *mandi* charges ends up escalating the prices for the consumers without commensurate benefit to the farmer. NAM addresses these challenges by creating a unified market through online trading platform, both, at State and National level and promotes uniformity, streamlining of procedures across the integrated markets, removes information asymmetry between buyers and sellers and promotes real time price discovery, based on actual demand and supply, promotes transparency in auction process, and access to a nationwide market for the farmer, with prices commensurate with quality of his produce and online payment and availability of better quality produce and at more reasonable prices to the consumer.

7. Integrated farming system

Food security, livelihood security, water conservation, conservation of natural resources and protection of environment have are the major issues discussed worldwide

during recent years. Sustainable development is the main focus for promoting rational utilisation of resources and environmental protection without impeding the economic growth. Integrated Farming System approach has multiple objectives of sustainability, food security, poverty reduction and farmer security.

Integrated Farming System (IFS) holds a special position within the broad concept of sustainable agriculture. Under Integrated Farming System, nothing goes wasted, the by-product of one system becomes the input for other system for example, cattle dung mixed with crop residues and farm waste can be converted into nutrient-rich vermi-compost. Integration and judicious mix of various agricultural enterprises viz., crop production, animal husbandry, poultry, fishery, forestry, horticulture, piggery, etc. would bring prosperity in the farming (TNAU). The adoption of multiple farm enterprises in an integrated manner can ensure a substantial income generation to sustain the livelihood of farmers over the meager income from self-standing enterprises (Ponnusamy&Kousalya Devi, 2017). Agriculture experts and scientists are stressing upon the need for IFS for realising the government's vision of doubling farmers' income by 2022 (Financial Express, 2017). Jintendra Chauhan, Advisor, Union Agriculture Ministry said that Integrated farming with animal husbandry, poultry, fisheries as its extra tool, need to be made part of the government policy.

Conclusion and Remarks

Rapid transformation is being observed in the Indian agriculture since introduction of Green revolution during 1960's. Advancements in the field of science and technology with increasing population and urbanization are the important factors driving the course and evolution of agricultural research. From 50 million tons in 1950, India's foodgrain production rose more than five times, to over 277.5 million tons in 2017-18. Combining Agriculture technology with the Information technology is the need of the hour for improving the agriculture sector. India is expected to achieve the ambitious goal of doubling farm income by 2022.

It can be stated that along with coping up the major challenges such as climate change, boosting farmers' income and feeding the billions, recent developments in agricultural research such as Agri-farm-tourism, Big data analytics, integrated farming and advanced marketing models are seen as ray of hope for sustaining Indian agriculture. There is a severe need for aligned amalgamation of various stakeholders like producers, consumers and public private partnership in order to bring new dimensions of Indian agriculture and sustain for upcoming challenges.

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