Rationale of Nation Building via Skill Development of Indian Farmers

State Profiles

VOL-3

Patanjali Farmer Samridhi Programme

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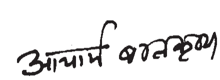
Foreward

The Patanjali Farmer Samridhi Program (PFSP) is being implemented by the Patanjali Bio Research Institute since 1st September 2018 with association of National Skill Development Corporation (NSDC) and Agricultural Skill Council of India (ASCI) for imparting training for the job role of Organic Grower and Group Farming Practitioner. The PSFP has successfully completed the training on organic grower of over forty two thousand farmers from various states of India and its journey is marked by both achievements and challenges faced during the programme implementation. The PSFP has experimented various agricultural practices and provided a strong commitment on Organic Agriculture focusing on Farmers Welfare.

This publication is a compilation of statewise profiles of various districts from across the country in which they experimented with Organic Agriculture and Chemical free farming in their own fields under the programme. Statewise profiles providing insights for the improvement of income of small and marginal farmers by adopting organic farming practices. The approach adopted by Patanjali to conduct the training and farm experiments in the farmers field under the Farmer to Farmer led extension model also energized and motivated not only the farmers but also the nearby farmers who were able to see the changes during the crop cycle.

I am sure that the statewise profiles provide proof of concept for analyzing the cost and benefits from organic farming through reduction of input costs and improved marketing practices being followed by the farmers. This will help to create a strong motivation on organic farming and contribute to the improvement and doubling of farmers' income in various states. I also complement the project team for working in the field and in documenting the report meticulously.



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Last but not the least the farmers associated under the program especially all those mentioned in the profiles have been extremely cooperative and helpful while sharing their experiences and insights during the implementation of this program and their contribution for promotion of Organic Farming is sincerely acknowledged.

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Patanjali Farmer Samriddhi Program team.

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Introduction

Food security for the bulging population of the country, sustainability of high agricultural productivity, improving economic conditions of the small and marginal farmers, limiting natural resources and adoption to climate change impacts are the key challenges for India, as on today. The diversified agriculture in 20 Agro-eco-regions (revised in 2015) and 60 AESR (revised in 2018) with the high yielding varieties/hybrids along with mechanization at larger scale, improved irrigation and high fertilizer consumption helped the country to achieve self reliance for food during the green revolution era. But, the country's rainfed areas couldn't get much attention and most of the privileges have been taken by irrigated agriculture. Today, while the country has enough food for the current population and even is earning foreign revenue by exporting agricultural produce, a large number of farmers who are small or marginal, have huge debts with low returns from farming. Considerable number of cultivators have become agricultural labourers. A large number of disappointed agricultural workers have left the farming and joined other high paying manufacturing sectors. Thus, the agriculture labor scarcity stood as a monster issue for the existing farming practitioners and the Government.

The injudicious use of chemical fertilizers and pesticides not only deteriorated soil health but also contaminated the groundwater. The soils are exhausting rapidly in irrigated agriculture and the groundwater tables are depleting. The agriproduce, although higher in volumes, contains poison in the form of heavy metals. This contaminated food is causing dreaded diseases among both urban and rural populations. The mechanization of farming has helped to meet the labor challenge but again the tailored mechanization would be more effective based on agroecology of a particular geography. Most of the landholdings have been getting smaller due to population pressure and bigger size equipment like combine harvesters are valid and affordable for big landholdings only. Intervention of the customised implements for small landholdings would be appropriate. Rice stubble burning in the rice-wheat system of North-western India has been causing the thickened aerosols over the National Capital Region and has become a threat to the lives of millions of people residing in the region. A large number of lung disease patients can be seen getting treatments in Delhi and other NCR hospitals. Crop residue management has become a challenge not only for farming community but also the ecosystem and human and livestock health, as stubble burning is deteriorating the soil ecosystem as well.

Climate Change impacts are now visible causing erratic and unpredictable monsoon patterns, floods, droughts and extreme heat events. Further, the irrigation water demand is on increasing trend with shrinking water resources and increased evapotranspiration due to increase in temperature (In Haryana, during summer - 2019, the temperature was 4oC higher than normal). The soil organic carbon status in the rice-wheat system has gone as low as 0.2 percent. Deforestation during the last 5 decades for urban expansion and industrial requirement, and degradation of forests have created uncertainty in monsoon rainfall. Intensive chemical agriculture exhausted the organic carbon and micronutrients from the soil.

High level Panel of Experts (HLPE) advocates seven PANTHER principles of Participation, Account-ability, Nondiscrimination, Transparency, Human dignity, Empowerment and the Rule of law should guide individual and collective actions to address the four dimensions of Food Security and Nutrition at different scales (FAO, 2019). Restoring the soil and water ecosystems is the main concern to mitigate climate change impacts. Economic development and resilience can be achieved by the focus on short-term yields and profits, enhancing nutrient use efficiency, water use efficiency, use of biofertilizers, growing legumes and risk management over long haul (Verma et al., 2019). Prioritization of climate smart technologies based on biophysical factors and quantitative assessment of vulnerability indicators is desired to achieve the higher adoption at farmer level. One of the Climate Smart Agriculture Technologies is Organic Farming. Organic agriculture empowers farmers by helping them design agronomic systems that are more resilient towards the impacts of climate change, by enabling them to reduce dependence on external inputs, and by promoting the development − rather than the degradation − of the natural resources on which we depend for food production (IFOAM, 2016).

Less developed regions exhibit low income levels of agriculture workers. Agroecology can be considered a scientific discipline, a series of cultural practices and/or a social movement aiming at developing cropping and farming systems based on the best use and conservation of natural resources and the minimum use of external inputs (Wezel et al., 2009). To achieve the DFI targets, technological and Policy interventions targeting high potential districts in less developed Agro-eco-subregions (Srivastava et. al., 2019) and the enhancement of productivity in rainfed areas (FICCI, 2015) are the need of the hour. An agro-ecologically managed multi-functional organic system for small/marginal farmers, where the produce is sold at local/regional markets, must seek optimization of production, cost reduction, and a better access of labor at peak times (Barberi, 2019).

To ensure efficient adoption of technology interventions, community based farmer to farmer approach is an effective and systematic utilization of community leadership and informal communication between farmers. The approach gave excellent results in African and South-East Asian countries. Performance of cultural techniques for weed control and that of bio-pesticides for pest management need to be evaluated under field conditions, preferably under cultivators' management conditions (NAAS Policy Paper 30). The farmlab establishment in the field of a leader farmer for a long term is highly effective and communicative among the local communities.

Further, connecting the organic producers to customers in urban areas and ensuring a good market for getting them a higher price is still a challenge. The formation of FPOs and assisting them in registration under PGS scheme will ensure an improved income and high returns, which in turn will not only fetch them double income but also improve their soils, thereby sustaining the agriculture in the AESRs. AESRs can be the representatives of diverse food systems. High Level Panel of Experts (FAO, 2019) set up by UNFAO has recommended Integration of transdisciplinary science and local knowledge in participatory innovation processes to transform these diverse food systems. The panel recommends supporting use of participatory and inclusive territorial management planning to identify and foster locally sustainable practices; building adaptation of international agreements and national regulations on genetic resources and intellectual property; strengthening the regulations on the use of chemicals harmful for food systems and the ecosystems, promoting alternatives to their use and rewarding practices that produce without them; Building social capital and inclusive public bodies at territorial landscape scale (10-1000 km2); Support food value chain innovation platforms, incubation and aggregation mechanisms, exploring the support in developing the local and regional markets , processing hubs and transportation infrastructures that provide greater processing and handling capacities for fresh products from small and marginal farmers adopting agroecological and other innovative approaches; Encouraging incentives for young entrepreneurs, women and community led enterprises that capture and retain value locally, recognizing and addressing their constraints and needs; harnessing the use of recent developments in dgital technologies to strengthen the links between food producers and consumers; adapting support to encourage local food producers, food enterprizes and communities to build recycling systems by supporting the use of animal waste, crop residue and food processing waste in forms such as animal feed, compost, biogas and mulch.

The key hypothesis of the project in context of the Farm Labs established are as follows:

Hypothesis 1

The project will contribute to doubling farmers income through Good Agricultural Practices by applying organic inputs in farmers field which will lead to the improved productivity of safe food in select agro-ecosystems. Better marketing and other interventions will also contribute to increased incomes.

Hypothesis 2

The project will facilitate the training through trainer farmers leading to awareness about soil health, organic farming, formation of common interest clusters, Farmer Produce Organizations, networking amongst farmers and sustainability of the interventions.

Objectives

- To demonstrate methodologies and principles of organic farming to farmers in order to achieve chemical free safe agriculture produce by using natural and organic inputs without disturbing environment and eco-friendly approach.
- To enhance the understanding of farmers on critical factors in the selection of crops and cropping patterns.
- To create an understanding on judicious use of natural resources such as soil and water.
- To provide basic awareness on seed and cropping systems.
- To sensitize the farmers on Good Agricultural Practices (GAP).

Framework Developed by DFI Committee

The Govt of India has documented some key strategies to implement for doubling the farmers income in volume - II of the report prepared by DFI committee ‘marking a significant departure from the past policies. The approach would consider four pillars viz., quantum and price of output, quantum and price of input. The report concludes that there is considerable seasonal and regional variation in the various components of income, including cultivation, livestock, non-farm business, wages and salaries and the share of cultivation in income ranges from 33-64 percent barring union territories where the average income through cultivation is 14 percent. According to the DFI Committee, the estimated income of agricultural households for small and marginal farmers in 2015-16 is Rs. 79,779 at current prices. The corresponding figure for large farmers is Rs. 6,05,393, which points to a significant variation in income across land classes. Hence, differential strategies need to be implemented based on the size distribution of land owned by agricultural households.

To achieve the desired growth rate of 10.36 per cent per annum in farm income, the investments ‘in’ and ‘for’ agriculture are vital. The improvement in viability of agriculture could be achieved by increasing farm income as a ratio of the total farmer income. The need of the hour is to ensure the location specific investment decisions based on the estimated capital at disaggregated level of state and districts. The capital formation can be accelerated by implementing policies that would attract stakeholders from the private corporate sector as well as the formal and organized sector apart from farmers.

Crop diversification can be another value addition to enhance the income of the small holder farmers, as the Horticulture crops bring significant enhancement to the income of the farmers without impacting the immediate food security. The area currently under less remunerative crops can be replaced by the Horticultural crops, which will fetch higher returns to the farmer and will also help in mitigating climate change. The connectivity to the market needs special attention as there are 36% postharvest losses due to continued shortfall in market connectivity and storage facility with the smallholder farmers. Further, the agri-logistics should be accompanied with market reforms like the sale of the produce should be allowed out of the mandis. Currently, the trader dominates the fruits and vegetable market accounting for 47% of the total purchase. The cold chain/ agri-logistics infrastructure would be instrumental not only in strengthening the linkage between MSMEs and large enterprise and incentivize the small entrepreneurs in local processing industry but also offer employment opportunities to local off farm/non-farm rural youth.

Substantial increase in the cost and consumption of material inputs has led to the decline in net income from the crops during the past two decades. Forced sale of material inputs led to injudicious use although not contributing significantly to productivity and the production. Income analysis for various crops has been discussed in the report volume-II, which concludes a mixed picture of the states and the decline in net income to the extent of negative in many areas. By and large the value of output increased during the last two decades, but the cost of input was higher than the increase in value of the output, which resulted in lowering of the income from many crops. Many paddy growing states registered negative income during recent years. Average net income from onion and cash crops like cotton and sugarcane significant improvement while the potato cultivation showed a declining trend during 2004-05 to 2013-14.

While discussing the possible strategies aiming to double the farmer's income, the report mentions the preferred strategy to the increase of farmers income from 60 percent in 2015-16 (base year) to 70 percent by 2022-23. This is assuming that growth of the non-farm component of income would be at a higher rate of 5.7 percent compared to the ongoing rate of 3.25 per cent over this period.

The policy recommendations made by the committee are based on both short term and long-term measures. Short term measures included the need to reform respective marketing systems by the state governments by replacing erstwhile APMC act where the wholesale auction system has been quite opaque, with the pattern of model APLM Act 2017, enabling the farmer to realize higher returns from his produce in the market. Diversification into high value produce of a perishable nature such as horticulture, livestock and fisheries, as it contributes to the significant increase in income. The strengthening of linkages among micro, small and medium MSMEs; and developing cold chains and other agri-logistic systems would accelerate both farm and non-farm incomes. To improve the input use efficiency, resource conserving technologies like zero-till micro irrigation; mechanization of specific agricultural operations; crop diversification in favor of horticulture and fisheries; integrated pest management; integrated farming systems approach; integrated agri-logistics; farm extension services; adaptation to climate change as being implemented by NICRA; and agri-market reforms at the state levels. To strengthen the input delivery mechanism, especially about seeds and extension services, and enhance the efficiency of public agencies within the existing institutional set-up. To give the small and marginal farmers from rainfed and vulnerable areas access to institutional credit and reduce their current dependence on non-institutional credit. To raise investment intensity and improve capital use efficiency in the infrastructural projects of the government, including irrigation, energy and others, by investing in area-specific and domain-specific needs, in order to maximize dividends with effective governance and institutional interventions. To facilitate the incentivization of private and corporate sector participation which is currently as low as 2 percent. Strengthening of the investment from the private sector in reforming the marketing systems, land lease laws and contract farming. The mobilization and their efficient utilization by the ministry of Agriculture and Farmers Welfare by drawing the policies which would encourage private sector investments. The measurement of components like farmer's income, savings and investments on a regular basis so that the monitoring and course correction interventions can be done from time to time. There have been data gaps in these components otherwise.

The long-term measures include the growth in private sector investments annually at the rate of 12.5 percent which is merely 2 per cent currently. And the acceleration in investments from the Public sector to the level of 16.8 percent, which is attained till now up to 12.45 percent only. The committee advocates a greater emphasis on agriculture research and extension and to step up investments in less developed and rainfed regions for meeting the future growth challenges in agriculture and increase focus on raising capital intensity in irrigation, energy, education and infrastructure to accelerate growth. Rationalization and targeting of input subsidies towards small and marginal farmers in the less developed states will trigger the growth through an increased input use. The formation of Farmer Producer Organizations and self-help groups to scale up post-harvest operations, mechanization and link them to the markets beyond mandis.

Government Initiatives

Farmer FIRST Approach

ICAR has taken an initiative recently known as ‘Farmer First Program (FFP). The program is developed as a concept to keep the farmer in a centric role for research problem identification, prioritization, and conduct of experiments and its management in farmers’ conditions. The focus is on farmer’s Farm, Innovations, Resources, Science & Technology (FIRST). The concept argues that in the past, the vital factor in the production system was raising production and productivity and addressing issues of the farmers and the technology. The knowledge and innovations of farmers were not valued. Now, with the increased number of small holders, growing proposition of women led agriculture, climate change, need for higher returns per unit area changing socio-economic environment, etc. the project development should involve innovation and technology development with the strong partnership of the farmers for developing location specific, demand driven and farmer friendly technological options. Farmer FIRST is an opportunity for the researchers, extension professionals and farmers to work together and find appropriate ways through assessing different solutions (ICAR, 2011). Farmer FIRST can be applied not only at household level but also at village as community experimentation. These experiments need to be adapted to specific conditions of a farming system and to have the participation of the farmers as well as scientists. The local wisdom as a vital element for the development of useful innovations. Such farm level experimentations give opportunity to the farmers to try new ideas independently, improve experimenting and technology development capacity, learn and share production experience with outside actors and other farmers; and better access to extension programs, services and information about technologies, markets, prices, etc. These farm level experiments give opportunity to researchers & trainers to learn local wisdom through working with farmers, implement research that suit farmers’ conditions, improve research methods and facilitate field-based learning, improve knowledge and skills in participatory research approaches.

Farmer to Farmer Approach

In the currently prevailing pluralistic extension system, there are various existing gaps viz., technological, information, yield, income, accessibility to food and livelihood opportunities etc. The public extension system and extension workers have been found to be accessed by only 5.7% households. Only 4.8% of the small farmers have been found to have access to public extension workers as compared to 12.4% of large farmers (Meena et al., 2016). The origin of farmer to farmer (F2F) extension model is from African countries. In the 1970s, F2F approach was implemented in Guatemala, which spread to Nicaragua in the 1980s and then Mexico and Honduras. It is currently practiced widely in Asia, Africa and Latin America. Scarborough (1997) described Farmer to farmer extension as “the provision of training by farmers to farmers, often through the creation of a structure of farmer promoters and farmer trainers.” Campesino-a-Campesino is the most famous movement in Nicaragua, in which the farmer trainer is at the centre of the approach. These farmer trainers are known by many names in various countries, but in Nicaragua, they are known as promoters. In Kenya, they are called Farmer Teachers (Amudavi et al., 2009), In Burkina Faso, farmer trainers are known as farmer advisors (Lenoir, 2009), while in Peru, they are known as Farmer Extension Agents or kamayogin (Hellin and Dixon, 2008).

Farmer to Farmer extension approach in agriculture is a systematic utilization of community leadership and informal communication between farmers. This approach aims to strengthen the information flow and enhance the agricultural production (Meena et al., 2016). In the F2F approach, first the lead farmers are selected who are called model, master, or lead farmers and they are chosen according to their agricultural expertise. In other initiatives, they are called the promoters or trainers, emphasizing their networking or training skills. The process of F2F model includes planning a structure to understand the underlying problems of the community, then selection of lead farmers from the community itself, having good agricultural background, basic literacy, communicative skills, trustworthy, actively participate in trainings and reachable to every stakeholder (Simpson et al., 2015). The lead farmers then are trained about the approach, the tools, technology and methods including extension methods. They are the first to experiment with the approach on their field. Further they transfer the knowledge and skills to other farmers of the community through model farms (which is named here as "farm lab"), community networks, practical trainings, etc.

Later, the effectiveness of the approach is measured by scaling the efficiency of stakeholders and the extent to which the objectives are achieved. Adoption of the approach by the community, augmentation in the production and productivity level and initiative towards innovations are also the measures of effectiveness. The benefits through F2F approach to the farmer include gain of knowledge at minimal cost and high benefits; improved social status among the community due to increased knowledge; increase in social networking; additional income generation through better knowledge; early access to new technology; and "feelings and behavior that show a desire to help other people and lack of selfishness".

Farm Lab is not a very new concept. In the United States, after the death of JI Rodale, his son Robert Rodale purchased 333 acres of land near Kutztown and developed it as farm lab for organic farming. He hired eminent scientists with strong credentials and started an era of organic research through validation. Later, this one of the oldest farm lab in the world became Rodale Institute and influenced the US Congress to allocate funds for Organic Agriculture in the country. In most of the countries, agriculture universities and research stations have agriculture research farms. However, at farming community level only demonstration plots were maintained by fertilizer and other input companies. The concept of farm lab for Organic Farming Extension is adopted innovatively under Patanjali Farmer Samriddhi Program at small farmer community level.

Major Emerging Challenges in Indian Agriculture

Crop Residue Management

A thrust on increasing food production during the green revolution in India brought several challenges. As the area increased under rice, maize, wheat, sugarcane, cotton, jute, soybean, rapeseed, potato, barley and horticultural crops, more volume of crop residues has been generated. A total crop residue biomass generated in India is 686 million tons (Hiloidhari, 2014). More than 275 million tonnes of paddy straws are generated annually (Anonymous, 2014; Veena and Pandey, 2011) in various rice growing states. Some of the crop residue is utilized as fodder, mulch and compost and some part remains unutilized, which is called surplus. The availability of surplus crop residue is maximum from cereal crops, followed by sugarcane and maize. The generation of crop residues is highest in Uttar Pradesh (60 mt) followed by Punjab (51 mt) and Maharashtra (46 mt) (Anonymous, 2013). Estimated crop residue in India annually is 84-141 mt., where cereals and fibre crops contribute 58 percent and 23 per cent respectively. Out of 82 million tons towards surplus crop residue from cereal crops, 44 mt are obtained from rice crops which are mostly burnt at the farm itself (Derpsch and Friedrich, 2010).

Nearly 30 million tons of paddy straw are generated in Punjab and Haryana. About 7 million tons is removed for alternative uses like power generation, biofuel, feeding of animals and for heat generation etc. Remaining 23 million tons of paddy straw (from 2.8 million ha) is burnt in the field as an easy and quick method of disposal. Burning of 23 million tons paddy crop residue in North-West India leads to a loss of about 9.2 million ton of carbon equivalent per year and a loss of about 1.4x105 tons of Nitrogen (Equivalent to Rs. 200 crores) annually (Singh et al., 2019). One-ton rice residue releases 13 kg particulate matter, 60 kg CO, 1460 Kg CO2, 3.5 Kg NOx and 0.2 kg SO2. The burning of residue causes phenomenal pollution problems in the atmosphere and huge nutritional loss and physical health deterioration to the soils. The residue burning increases the subsoil temperatures to nearly 33.8-42.2 oC at 10 mm depth (Gupta et al., 2004), and long-term effects can even reach up to 15 cm of the topsoil. Frequent burning reduces nitrogen and carbon potential of the soil and kills the microflora and fauna beneficial to the soil, and further removes the large portion of the organic matter. With crop burning the carbon-nitrogen equilibrium of the soil is completely lost [56,57].

According to NPMCR (National Policy on the Management of Crop Residues), it is reported that the burning of one ton of straw accounts for the loss of the entire amount of organic carbon, 5.5 kg of nitrogen, 2.3 kg of phosphorus, 25 kg of potassium and 1.2 kg of sulphur. On an average crop residue of different crops contain approximately 80% of nitrogen (N), 25% of phosphorus (P), 50% of sulphur (S) and 20% of potassium (K). If the crop residue is retained in the soil itself, it can enrich the soil with C, N, P and K.The burning of rice residue is environmentally unsafe as it causes problems for human health and greenhouse gases (McCarty, 2011; Gupta et al., 2004; Jain et al., 2014) that add to global warming and climate change. However, the incorporation of crop residue, which is the next alternative, costs 20 percent more than the cost of a full burn of paddy straw management technique. It has also been reported as a major constraint in the rice-wheat cropping system following a short time period available between rice harvesting and wheat sowing.

Currently, the rice residue is utilized as livestock fodder, livestock bedding, in-situ incorporation, composting and generating electricity, mushroom cultivation, roof thatching, biogas, furnace fuel, biofuel and paper and pulp board manufacturing etc. But presently only 15% of total rice residue generated in North-West India is being utilized for the above practices. Cost effective and scalable options for managing crop residue and sustainability of Rice-Wheat System are still a challenge. There are two alternate and safe methods for straw management - in-situ and Ex-situ. In-situ methods are financially the most viable and workable option in the immediate short run (Singh et al., 2019).

The studies suggest that in-situ incorporation of crop residues not only play an important role in buffering soil moisture and temperature but also replenish the soil nutrients and organic matter in addition to reducing carbon footprints. Major constraint in in-situ management of rice residue was the availability of machines for drilling it in the field. But latest technological innovation as a combination of state of the art 'Super SMS' (fitted with harvesting combine) and Turbo Happy Seeder has been widely recognized as a key for direct drilling through the heavy surface residue load. The significance of the technology has been established through validation over years in diversified cropping systems. The same equipment can be used for direct drilling of wheat after rice harvest. The residue mulching is another utilization of crop residue, which is an important facilitator of microbial and enzyme activities in the soils which leads to better soil quality index and improve soil, plant and water relationships in organic farming systems.

However, high lignin content (Sarkar et al., 2012) hampers the faster decomposition and fermentation of rice crop residues. While the presence of high silica content provides pest and disease resistance, biotic/abiotic stress resistance and improved light interception ability of the plants. High silica content however reduces straw digestibility in livestock rumen (Li et al., 2010).

Rice is primarily a crop of marshy conditions and shallow groundwater areas with high rainfall. These suitable conditions are however, not available in Punjab, Haryana and Western Uttar Pradesh. Continuous rice cultivation in these states for the last 50 years has driven the state from food deficit to food surplus. But it resulted in depletion of groundwater resources, nutrient deficiencies and drainage of soil organic matter from the soil, emission of greenhouse gases contributing to climate change and environmental degradation (Singh, 2016). There seems to be no other option but to reduce area under rice cultivation in these highly vulnerable regions and to shift to other alternate crops (Samra and Singh, 2019) and integrated farming systems (FAO, 2016). Indian Institute of Farming Systems Research at Modipuram (Meerut) and its centres conducted location specific research and identified several cropping systems which have better productivity with same or even less water consumption than rice-wheat system. Haryana Government attempted to promote Maize instead of rice among the farmers of Haryana with incentive.

But there seems to be a lack of confidence and poor extension efforts. The programs by state governments to replace the existing system with alternative crops could not succeed during the past more than 10 years. Policy support and massive value addition demonstration campaigns in cropping systems may encourage the confidence of the farmers to adopt the alternate crops. Diversification into farming system mode in smallholder farming appears promising to secure food, nutritional and environmental security at the grass root level (Singh, 2009, Singh et al., 2007). Several experiments on farming system research in the country revealed enhanced nutrient and water use efficiency and profits when livestock, fisheries, poultry, piggery and horticulture were associated with crops (Singh and Toor, 2004).

Climate Change

Agriculture and climate are inextricably linked. Agriculture is both a victim and a cause of climate change. Agricultural production relies fundamentally on the weather. Increasing severe weather patterns such as droughts, floods, desertification and disruption of the growing seasons in many parts of the world have resulted in negative impact on agricultural production. Climate change is emerging as a major threat on agriculture, food security and livelihood of millions of people in many places of the world (IPCC, 2014). Several studies indicate that agriculture production could be significantly impacted due to increase in temperature, changes in rainfall patterns (Prasanna, 2014). Changes in crop cultivation suitability and associated agriculture biodiversity, decrease in input use efficiency, and prevalence of pests and diseases are some of the major causes of climate change impacts on agriculture (Punna Rao et al., 2019). The negative impact of climate change is region-specific and is more severe in developing regions such as Africa, Latin America, South-East Asia and India (William, 2007). The estimated impacts of both historical and future climate change on cereal crop yields in different regions indicate that the yield loss can be up to -35% for rice, -20% for wheat, -50% for sorghum, -13% for barley and - 60% for maize depending on the location, future climate scenarios and projected year (Porter et al., 2014).

In India, the impact of 1-20C increase in mean air temperature is expected to decrease rice yield by about 0.75 t/ha in efficient zones and 0.06 t/ha in coastal region; and impact of 0.50C increase in winter temperature is projected to reduce wheat yields by 0.45 t/ha. (DFI Volume 5, 2017). Studies conducted under the National Network Project on Climate Change (2004-13) to assess the impact of medium term (2010-2039) changes in climate on Indian agriculture indicated an average reduction in productivity by 4-6 per cent in rice, 6 percent in wheat, 18 per cent in maize, 2.5 per cent in sorghum, 2 per cent in mustard and 2.5 per cent in potato besides significant regional variability (Naresh Kumar et al., 2012).

The solution of climate change caused by agriculture lies in selecting the best form of farming practices aiming cost-effective production with minimum adverse effects on the environment and climate. Adaptation options that sustainably increase productivity, enhance resilience to climatic stresses, and reduce greenhouse gas emissions are known as climate smart agricultural (CSA) technologies, practices and services (FAO, 2010, 2014). Broadly, CSA focuses on developing resilient food production systems that lead to food and income security under progressive climate change and variability (Vermeulen et al., 2012; Lipper et al., 2014; Verma et al., 2019). In general, the CSA options integrate traditional and innovative practices, technologies and services that are relevant for location to adopt climate change and variability (CIAT, 2014). Khatri-Chhetri et al., (2017) considered a technology or practice, climate smart if it can help to achieve either of the increased productivity, or reduction of GHG emissions.

Despite the various benefits of CSA technologies, the current rate of adoption by farmers is low (Palaniswamy et al., 2015). There are many factors that influence the extent of adoption of CSA technologies such as socio-economic characteristics of the farmers, bio-physical environment of a location, and the attributes of the new technologies (Campbell et al., 2012; Below et al., 2012; Deressa et al., 2011). While designing CSA implementation strategies at the farm level, one must consider adaptation options that are well evaluated and prioritized by local farmers in relation to prominent climatic risks in that location (FAO, 2012). Despite the importance of prioritization of CSA technologies at farm level, existing climate change adaptation programs lack such information for better adaptation planning. Evidence on farmers' prioritization can support key stakeholders make informed decisions that are in line with government policies and institutional arrangements (Verma et al., 2019).

One of the most promising CSA technologies is Organic Farming. Organic Farming has a long tradition as a farming system, and it has been adapted for many climate zones and local conditions. Organic Farming has a recognized potential as a development strategy for rural communities (El-Hage Scialabba and Hattam 2002; and Eyhorn 2007; DARCOF, 2000; Eyhorn et al. 2003; Halberg et al. 2006; "Organic eprints," at http://www.orgprints.org/). The advantage of Organic Agriculture is that it comprises a bundle of mutually adapted and optimized practices and is thus a whole operational farming system with a proven record of good performance. In addition, the certification available for the products of Organic Agriculture allows realization of higher prices (Muller, 2009).

In India, the rainfed area, which is 55% of the total cultivated area is being cultivated mostly by the marginal farmers, is most vulnerable to climate change and most suitable for adoption of Organic Farming as one of the CSA technologies. Additionally, the areas where the water table is depleting, Organic Farming will be contributing to climate change mitigation by improvising the soil organic carbon, which is the key for enhancing health and water retention capacity of the soils. For a wide adoption of Organic Farming, not only Its necessary to educate the farmers about technological interventions but also, honest efforts by the state departments of agriculture and other stakeholders are desired for establishing good connectivity among the farmer groups, certification and marketing agencies, in order to achieve the increased income to the farmers through good agricultural practices.

Degradation of Natural Resources

The emphasis in agriculture after independence has been on exploitation of natural resources of land and water and less on improving, restoring and enhancing their productivity and sustainability. The unstable use and inappropriate management practices have led the Indian agriculture in a critical state. The land degradation stemmed out due to illegal deforestation, unsustainable wood and fodder extraction, shifting cultivation, encroachment into forest lands, forest fires and urban expansion on prime agriculture lands in the vicinity of the cities. Non-adoption of adequate soil conservation measures, improper crop rotation, indiscriminate use of agro-chemicals such as fertilizers and pesticides, improper planning and management of irrigation systems, and extraction of groundwater in excess of the recharge capacity further aggravated the degradation process.

The dynamic process of land use change revealed that the net cultivated area increased significantly by 11.8 per cent from 119 million ha. In 1950-51 to 140 million ha. In 1970-71 and since then it has been stable. Although there has been a 19 percent increase in net sown area has increased, the population has nearly tripled. The cropping intensity has increased from 111 to 135 percent, while the area under non-agricultural land use has gone up by a whopping 165 percent. Barren and uncultivable lands reduced by about 54 percent, fallow land other than current fallow by 38.5 percent, while the current fallow has gone up by 33 percent (DFI Vol. V, 2017).

In some of the states, 70 percent of the irrigation is supported by groundwater, which has led to overexploitation of aquifers. Although the net irrigated area has now gone up by 63 million ha. Out of 140 million ha. net sown area, the overall irrigation efficiency is ascribed as low as 38 percent in the country. The long gestation period in the completion of dam/head work, dilapidated irrigation systems, unlined canal systems, lack of field channels and proper drainage, low rates for water supply, inefficient water application methods and inadequate extension services have been the major causes of low irrigation efficiency.

The chemical degradation involving loss of nutrients and/or organic matter, salinization and pollution, and physical degradation in the form of waterlogging, mass movement, landslides, compaction, crusting and sealing are reproduced below:

S. N.	Type of Degradation	Arable Land (m ha)	Open Forest (<40 percent canopy) (m ha)
1.	Water erosion (>10t/ha/yr)	73.27	9.30
2.	Wind erosion (aeolian)	12.4	-
	Sub-total	85.67	9.30
3.	Chemical Degradation		
	a) Exclusively Salt-affected soils	5.44	
	b) Salt-affected and water eroded soils	1.20	0.10
	c) Exclusively acidic soils (pH<5.5)	5.09	
	d) Acidic (pH<5.5) and water eroded soils	5.72	7.13
	Sub-total	**17.45**	**7.23**
4.	Physical Degradation		
	a) Mining and Industrial waste	0.19	
	b) Water logging (permanent) <2 m	0.88	
	Sub-total	**1.07**	
	Total	**104.19**	**16.53**
Grand Total (arable and open forest)		**120.72**	

Source: Degraded and Wastelands of India, ICAR and NAAS, New Delhi (2010), 158 p.

In India, the extent of land degradation as per the harmonized data, is 120.72 million ha. Almost 5334 million tons of soil is lost due to various erosion ways, which works out to 16.35 tons/ha. (Dhruv Narayana and Ram Babu, 1983) of which 29 percent is lost permanently into the sea, 10% gets deposited in the reservoirs and remaining 61 percent is displaced from one place to another or redistributed. However, the highest rate of erosion occurs in Black soil region (23.7-112.5 t/ha). The analysis revealed that in the country 39 percent area is having erosion rates of more than permissible rate of 10t/ha/yr. About 11 percent of the area falls in the very severe category with 40 t/ha/yr erosion rate. Erosion contributes significantly in washing out of nutrient reserves from the top soil affecting thereby the agricultural productivity. The effect on loss of productivity is more pronounced in red soils followed by black soils and alluvium derived soils. A removal of 1 cm topsoil reduces 76 kg/ha of maize grain yield and 236 kg/ha of straw yield in lower Himalayan region (Khybri et al., 1988), while in Punjab maize grain yield reduced by 103 kg/ha. (Sur et al., 1998).

The on-site and off-site effects of land degradation include lowering of land productive capacity and decline in water quality respectively. Nearly 8.4 million ha. of irrigated land is affected by salinity and alkalinity, of which about 5.5 million ha is waterlogged (IDNP, 2002). In the command area of Tungabhadra irrigation project, about 6000 ha. Area is degraded annually due to salinity and water logging. Similarly, in the Nagarjuna Sagar irrigation Project, out of 1,40,000 ha. command area, almost 25,000 ha. is affected by waterlogging and salinity during 14 years of its commissioning.

Neglected Rainfed Area

Water is one of the most critical inputs in biological production systems like agriculture and is the greatest moderator of vulnerability and climatic variability. It is estimated that 74 percent of rice and wheat, the two most important food staples in the country comes from irrigated agriculture. But India's water resources are under considerable strain. India accounts for only about 4 percent of global water resources but supports about 18 percent of the World's human population and 15 percent livestock.

Almost 55 percent of cultivated land is dependent on monsoon (rainfed) and an effective management of available water is a substantive challenge before the nation. Almost 72 million ha. rainfed areas of India are characterized by aberrant behavior of monsoon rainfall, eroded and degraded soils with multiple nutrient and water deficiencies and declining groundwater table (DFI Vol VII, 2017). In addition to these, extreme weather events resulting from climate change pose a serious threat to rainfed agriculture. The rainfed agriculture holds a key position in ensuring food & nutrition security of the country, besides increases in farm incomes and equitability. The rainfed agriculture contributes 89 percent nutri cereals, 88 percent pulses and 69 percent oilseeds and 40 percent rice. About 67 percent of India's farmers rely on rainfed agriculture, with only 20-30 percent earnings from the farm related activities. The rainfed systems have been facing several adversities such as the ill effects of climate change and extreme events like drought, crop failure and non-remunerative prices.

On the other side, the irrigated agriculture area which is 82.6 million ha. Enjoys several privileges. Either free or low tariffs and subsidies on power have encouraged farmers to extract groundwater from the deeper aquifers.

Depleting Water Tables

India is the world's highest user of groundwater. Drinking water needs of the population living in villages depend on groundwater. Over 30 million groundwater access points supply 85 percent of drinking water in rural areas and 48 percent requirements of urban population. Most groundwater is used for irrigation, which accounts for 88 percent (Celeb Gorton, 2017). Groundwater is the main source of irrigation in 63 percent of the total irrigated area. In Indo-Gangetic alluvium, most of the large aquifers are overexploited and got contaminated with heavy metals like Arsenic. In the North-west region, around 95 percent of groundwater is used for irrigation. Which has brought the groundwater table to a depth of 40 meters below ground level in the elevated states Punjab and Rajasthan.

In peninsular regions of India, the crystalline groundwater aquifers are shallow with low storage. The consequences of overuse are localized, and the effects of depletion are more immediate than the alluvial systems. The state of Tamilnadu has experienced the worst water insecurity in the region. Due to the state's growth in groundwater usage for agriculture, the rate of groundwater depletion has been 8 percent higher than the rate of recharge.

Power for irrigation in many states is provided either free or at highly subsidized tariff, and this has incentivized the use of groundwater for agriculture. Subsidized or free power has encouraged the farmers to overdraw water from deep aquifers causing substantial depletion of water table and water quality deterioration in many cases. Due to unregulated water use, there has been unprecedented crop diversification to heavy water duty crops. The cropping systems are diversified to heavy water duty crops like rice, sugarcane, banana and cotton. While the areas do not fit into rainfall patterns and groundwater availability.

So far, very less attention has been given on sustainability of groundwater and resultantly, the cities like Chennai are exhausted and the states like Haryana are under threat of groundwater exhaustion. As per the current report from Central Ground Water Board (CGWB, 2011), 1,034 of the totals assessed 6,584 Community Development blocks are over exploited (referred to as dark). Furthermore, the Climate change, causing erratic rainfall patterns, is likely to impact the water availability for agriculture. Groundwater problems require immediate and diverse solutions. Varied hydrological settings of the country require case-specific management strategies. The large alluvial aquifers are best managed at a regional level, while community-based approaches are required for the smaller aquifers of south India's crystalline systems. The irrigation water use efficiency of India is very low. Which needs to be enhanced with appropriate water management strategies.

Deteriorating Soil Ecosystem

The soils of about 29.4 million ha. area in the country are experiencing a decline in fertility with a net negative balance of 8-10 m tons of nutrients per annum (DFI Vol. 5, 2017). The organic carbon in Indian soils is very low and deficiency of Nitrogen is almost universal. The status of Nitrogen is low in about 48 percent of the area and medium in about 42 percent. The phosphorus and potassium were also observed low in 25 and 27 percent area and medium in 67 and 70 percent area, respectively. The N use efficiency is already as low as 40 percent in low land and 60 percent in upland farming conditions. With the negative nutrient balance, fertilizer use efficiency is likely to decline further. In the states of North-west India (Indo-gangetic plains) where rice-wheat cropping system is followed, the overmining of secondary and micronutrients has already depleted nutrient reserves.

Nearly 3.7 million ha. Area is deteriorated due to depletion of organic matter. Organic matter in soils has a significant role in maintaining soil temperature, water retaining capacity and soil ecosystem. The removal or in-situ burning of crop residues and minimal or no addition of organic manures, and intensive cultivation are the major reasons to bring SOC level from 0.5 percent in the 1960s to 0.2 percent in the recent two decades (Sinha et al., 1998). Soils with low organic matter have poor soil biodiversity. Soil biodiversity is an indicator of soil health. The microorganisms form the ecosystem of the soil and break down the materials to nutrients available to the plants. There are normally 600 million microorganisms in the soil with good condition. In arid conditions, the population comes down to 1 million. Decline in soil biodiversity makes soil more vulnerable to other degradation processes.

In irrigated areas, seepage losses from unlined canals cause waterlogging and secondary salinity. In high water table areas (<2 m bgl), the groundwater with salts comes up and evaporates leaving the salts in upper crust. These salts degrade the soil conditions and inhibits the plant growth. High electrical conductivity and high pH with high Exchangeable sodium percentage are the indicators of saline-sodic soils of Uttar Pradesh and Punjab. Gujarat also has considerable area under salt-affected soils which are saline in nature. About 6.73 m ha. area of India's land is affected by salinity (Singh, 2018).

Waterlogging is caused when the rising water table reaches to plant root zone, impeding its ability to respire and ultimately compromising the yield (except rice). About 3.1 million ha. Agricultural land of India is waterlogged due to inadequate drainage, improper balance in groundwater and surface water use, seepage and percolation from unlined canals, over irrigation.

Deteriorated soil quality is affecting Indian agriculture adversely through yield loss, low input use efficiency, poor crop quality, reduced farmers' income and profitability, environmental pollution, and climate change. There has been significant slowdown in the growth rate of production as well as yield of rice and wheat in IGP after 1990s and the sustainability of the important cropping system is at stake (Ladha et al., 2003).

Injudicious usage of pesticides has contributed to the heavy metals in the soils, which reduce soil respiration, microbial activity and soil enzyme activity, inhibit crucial soil processes such as ammonification and nitrification, reduce earthworm population, and suppress algal population. These potentially harmful substances have accumulated in soils of many areas and are causing long-term effects on crop yields and quality and are damaging microflora. Through food and feed, they are reaching to human and livestock systems and are causing serious health concerns if exceeding threshold levels.

Deforestation

In India, a total of 24.39 percent of geographic area is under forest/tree cover as against the target of 33 percent according to 'National Forest Policy (FSI, 2017). The efforts through government policies have brought positive changes in forest conservation during the last few decades. There is a total increase of 6,778 sq. km. in year 2017 compared to the year 2015. Some states like Andhra Pradesh, Karnataka and Kerala have contributed significantly through forest conservation and plantation activities.

During the past, there has been diversion of forest to industries infrastructure, urbanization, unrestricted exploitation of timber and other wood products for commercial purposes, as also, slash and burn method of cultivation in some areas responsible for forest degradation. In some areas in North-eastern states, shifting cultivation is being practiced today.

Another serious consequence of forest degradation is the loss of biodiversity i.e. the extinction of thousands of species and varieties of plants and animals. Global warming is another consequence of deforestation. The impact of deforestation on soil resource can be severe. The major consequences of deforestation are economic loss, biodiversity loss, extinction of various species, reduction in stream flow (break in water cycle), increase in global warming, disruption of weather patterns and global warming, degradation of soil and acceleration of soil erosion, occurrence of landslides, increased flood frequency and magnitude, and break in nutrient cycle.

Loss of Biodiversity

Due to the massive commercialization of agriculture in recent past, the diversity in India has come under pressure. The farmers have been merely the recipients of research rather than a participant in it. This has led to an increased dependence on a relatively few plant varieties. The replacement of traditional varieties by modern varieties or High Yielding Varieties (HYV) has been one of the major compromises of biodiversity. Hybrid seeds era has eroded the original land races. Due to indiscriminate use of fertilizers and pesticides, the soil quality is depleted, and productivity has begun to suffer. The HYV seed and high input-based agriculture brought substantial increase in productivity but sustainability is lost. Several indigenous practices and seeds are lost, many of the species of the natural pollinating agents like honeybee are getting extinct. To ensure an optimal balance between practices bringing higher yields while protecting the ecology is a challenge today.

Agriculture Labor scarcity

Indian agriculture has marked its presence at the global level. The country is the world's largest producer of milk and pulses and second largest producer of rice, wheat, fruits, vegetables and sugarcane. India's food grain production has crossed 283 million tons in the year 2018-19. The production of rice has been 115.6 million tons and wheat has crossed 101 million tons. Sugarcane has been recorded >400 million tons. Despite the high production, the growth rate of the agriculture sector has slipped down to 2.7 percent from 4.6 percent last fiscal. Although, the contribution of the agriculture sector in GDP is 15-16 percent and significantly higher in comparison to the world's average (6.4 percent). The movement of excess agricultural workers from low productivity to high productivity sectors like manufacturing and services, and thus from rural to urban areas, and form lower wages to higher wages. As compared to agriculture, the labor is 4 times more productive in industry and 6 times more productive in service (Goldman Sachs, 2014).

KPMG (2015) discusses in its joint report with FICCI that Higher remuneration and growth of opportunities in alternate sectors coupled with the relatively lower rise in wages in agricultural occupations as compared to other sectors have led to the migration of workforce away from agriculture which has resulted in labour shortage and consequent escalation of cost of cultivation. Shortage of agriculture labor is not being compensated by adequate measures to reduce the overall labor intensity of the sector. As a result, the agriculture sector in many states is experiencing severe labor shortage and escalation in farm wages which are adversely impacting the profitability of the farmer. Furthermore, government schemes like MGNREGA which have facilitated migration of labour to other segments need to be reformed.

However, Prabhakar et al., 2011 identified the reasons for Labor scarcity in agriculture are higher wages in other locally available non-agricultural jobs, shifting to a regular/permanent job (agricultural job is seasonal), presuming agricultural labor a low esteem job, migration to nearby cities for higher wages, migration to urban areas due to improved education status, and migration to foreign countries. Labor scarcity impact is more pronounced in case of certain crops viz., Paddy, wheat, cotton, Sugarcane and Groundnut, which require significant amount of labor hours per unit cultivated area. In Gujarat, the number of farmers had to destroy their sugarcane produce due to shortage of labour in the year 2011. Promoting customized mechanization, direct seeding and developing effective herbicides, while considering the small landholders can be a good measure to meet the labour shortage intensity. Another factor is gender bias. For women, the agricultural daily wages are between 15-30% lower than those of men depending on the agricultural activity (KPMG, 2015).

Role of Patanjali in Organic Farming

Patanjali Bio Research Institute (pvt.) Ltd. is an organization based in the foothills of Himalayas on the banks of the river Ganges in the state of Uttarakhand. The organization has already been working as a mission based on "Concept of Organic Farming". The institute specializes in economically available biological products for agriculture applications to the farmers in 29 states. With state-of-the-art R&D laboratory and research facilities and a sound team of experienced scientists, it has developed a portfolio of more than 17 products which are one of the best solutions from soil management to pest & disease management, plant nutrient & health management. The organization claims that the products are cost-effective organic solutions with high shelf life. It helps farmers to control diseases, pests, improve plant health and increase the crop yield, while reducing the pesticide residue in foods. The response from the farmers to the products of PBRI is indeed very positive. The products are ISO certified and registered under Fertilizer Control Order (FCO).

Patanjali Farmer Samriddhi Program

To further expand the mission of Organic production, the organization approached the National Skill Development Council of India (NSDC) and was awarded a project under Pradhanmantri Kaushal Vikas Yojana (PMKVY) to train the farmers on organic farming during 2018-19. The scientists were trained by NSDC officials on the format designed by NSDC and Agriculture Skill Council of India (ASCI). The project envisaged to create a model for increased organic production leading to doubling the farm income through a demonstrative Farmer to Farmer (F2F) approach across 600 districts of the country. Multiple aspects like training of trainers, training of farmers, demonstrative farm labs, scientific research, changing dependence of farms from chemical fertilizers to organic, data mining, technology intervention for live updates to stakeholders, mobilization of trainees, large scale supply chain for distribution of inputs and buy-back of produce, farm insurance and creating a database of organic production etc.

The major objectives of the project were to bring 50 scientists on board for providing inputs and to work with 10,000 farmer trainers with 3 years handholding and document the data of the progress of the project on a daily basis; Development of trainer manuals (based on biophysical factors) for the crops being taken in different cropping systems and Agroeco-Regions, soils, weather, availability of irrigation water and socio-economic factors like Farmers capability to adapt to the changes; Identification of 10,000 farmer trainers across 600 districts who could motivate the farmers in their villages and provide 1 acre land as demonstrative farm lab for training purposes.

The institute developed a portable low-cost soil testing kit 'Dharti Ka Doctor' with the help of scientists, which has been distributed to all the farmer trainers. The kit can be used on field to test the soil samples for available Nitrogen, Phosphorus, Potash, pH and Soil Organic Carbon. With the help of kit, the instant results help the farmer to determine fertilizer recommendations according to the season and crop. After getting trained on the use of soil testing kit, those farmer trainers are testing the soil samples of their fellow farmers whom they have trained as organic grower under RPL program.

Under the PFSP, being implemented by the Patanjali Bio Research Institute, more than 42,000 farmers across 18 states of the country were trained through trained farmer trainers for the job role of 'Organic Grower' in partnership with National Skill Development Council and Agriculture Skill Council of India during the year 2018-19. The organization has a determination to further train 1 million farmers on the technology. The institute helped the farmer trainers in establishing one-acre farm lab and distributed bio fertilizer inputs during the crop season. The teams of PBRI are helping farmers in registering Farmer Produce Organizations (FPOs), certification and connecting them to organic produce buyers. In this special project the farmer trainers have been trained for the job role Group Farming Practitioner who in turn will train the farmers for the same job role under Recognition Prior Learning.

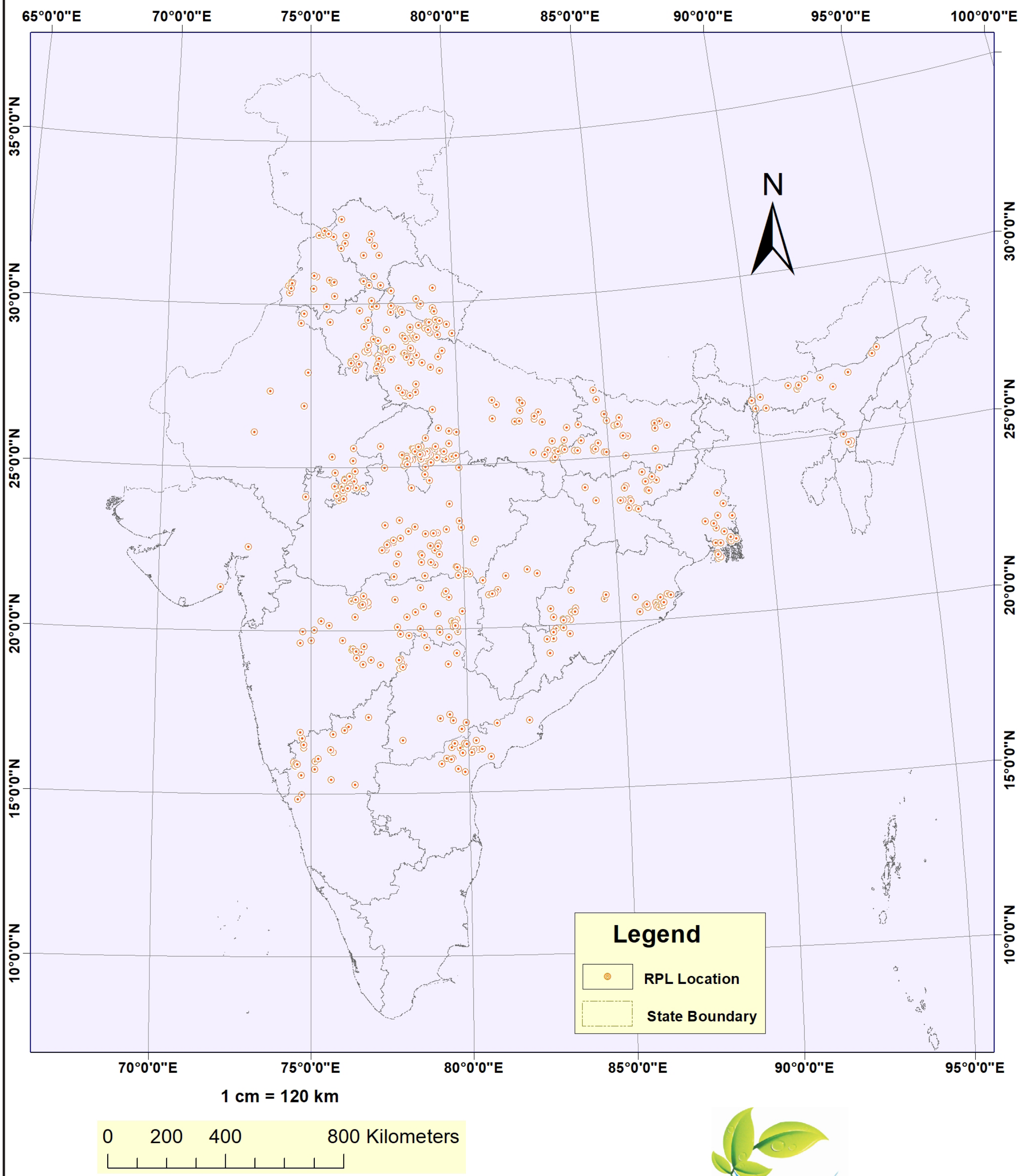
As one of the interventions under the project Farm Labs were established in 430 locations of the country in which the organic practices vs farmers practices were compared at the field level. The organic inputs for the farm lab were supplied by Patanjali and comprised of a mix of Bio manures, biopesticides and bioinsecticides as per the crops grown. The process of operationalization of Farm Labs is explained in Annexure 1.

Location and States/Districts Covered

A total of 178 districts in 18 states have been taken up in the project under Patanjali Farmer Samriddhi Program. 393 one acre farm labs are established.

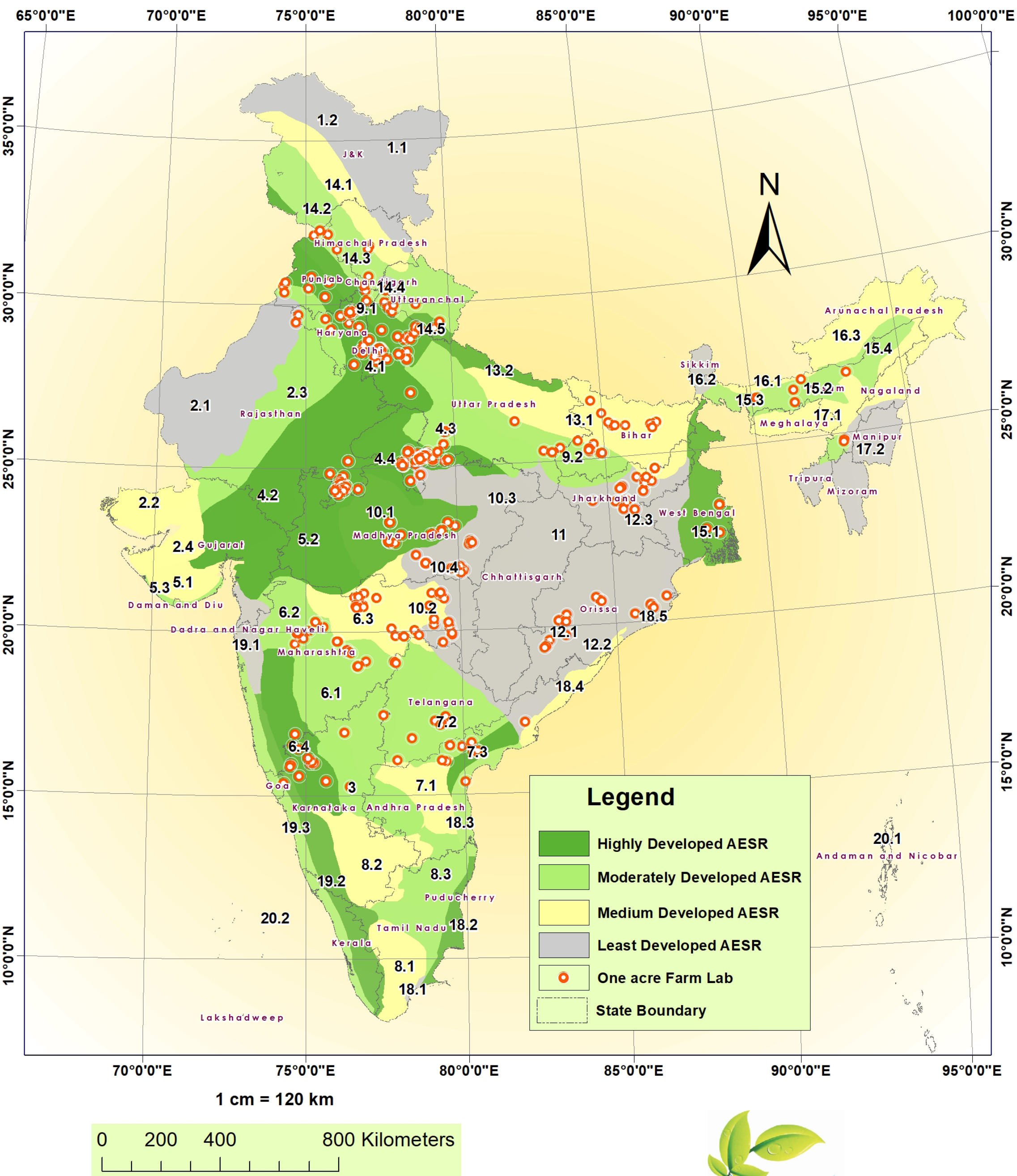
S. No.	Particulars	High developed (0.421–0.674)	Moderate developed (0.674 to 0.706)	Medium developed (0.706 to 0.781)	Less developed (>0.781)
	AESR	2.3, 4.1, 4.2, 4.4, 5.2, 6.4, 7.3, 9.1, 10.1, 13.2, 14.5, 15.1, 18.2, 19.2	3, 4.3, 5.3, 6.1, 6.2, 7.2, 8.3, 9.2, 14.2, 14.3, 15.2, 15.3, 15.4, 18.3, 19.3	2.2, 2.4, 5.1, 6.3, 7.1, 8.1, 8.2, 10.2, 13.1, 14.1, 16.1, 16.3, 17.1, 18.4	1.1, 1.2, 2.1, 10.3, 10.4, 11, 12.1, 12.2, 12.3, 14.4, 16.2, 17.2, 18.1, 18.5, 19.1
1	Composite ADI	0.602 (0.021)	0.689 (0.003)	0.744 (0.005)	0.830 (0.01)
2	Geographical area (m ha)	80.4	90.9	74.4	81.5
3	Farmer income (Rs/year)	95940 (6976)	84173 (3901)	83373 (6897)	70846 (9649)
4	Crop output (Rs/ha)	74311 (6122)	68980 (4939)	67724 (13924)	39600 (4031)
5	Crop output per agricultural worker (Rs/worker)	45359 (4477)	41136 (5820)	39870 (7447)	20224 (2851)
6	Cropping intensity (%)	150 (5.31)	138 (4.82)	127 (4.08)	124 (4.3)
7	Irrigation coverage (%)	64 (5.29)	37 (5.63)	34 (4.66)	33 (3.6)
8	Groundwater development (%)	79.42 (8.98)	50 (5.6)	47.44 (7.84)	38.08 (10.33)
9	Fertilizer use (kg/ha)	160.4 (18.22)	124.5 (17.75)	99.4 (16.35)	65.3 (9.59)
10	Credit use (Rs/ha)	68371 (13312)	63545 (13366)	58717 (19219)	43564 (8364)
11	Marketed surplus (%)	59.8 (2.94)	59.2 (4.15)	61.7 (4.2)	44.8 (4.32)
12	Access to technical advice (%)	22.4 (3.18)	24.7 (4.3)	15.7 (2.53)	11.7 (2.17)

RPL Locations Under
Patanjali Farmer Samriddhi Program



Patanjali Bio-Research Institute

Farm Lab Locations Under Patanjali Farmer Samriddhi Program



AESR - Agro Eco Sub Region

Patanjali Bio-Research Institute

Methodology Implementation

A formal inaugural function was organised Patanjali Yog peeth on 06 October, 2018. Almost 4500 farmers from various states attended the program and the Director General, ICAR, Dr. Trilochan Mahapatra was the Chief Guest apart from the NSDC and ASCI officials.

Training of the scientists of PBRI

As per the guidelines discussed in the proposal, the scientists were oriented about the project, NSDC, ASCI and 8 days training by ASCI officials on the prescribed format was organised in PBRI premises during 5-8 September, 2018. After the assessment, for each state, one scientist for each state was deputed as State Coordinator. Two regional level Directors were appointed to monitor and provide technical guidance to the state coordinators. Each State Coordinator was assigned the task to identify the interested farmers with leadership qualities from the districts of respective states. Each State Coordinator was facilitated with training assistants to collect farmers' details and documents and prepare a database before forming the batches of ToT and RPLs.

Training of Farmer Trainers

8 day (120 hours) training programs (ToT) for farmer trainers were organized in ICAR institutes and universities based on availability of good training hall, internet facility etc. after identification of eligible and interested farmers. The training programs were designed based on the guidelines of NSDC and Agriculture Skill Council of India the assessment agencies who were assigned the assessment tasks for particular batches of trainer farmers by the Agriculture Skill Council of India (ASCI) conducted the written tests using tabs and the technical experts from these agencies conducted the viva-voce of those trained farmer trainers. A total of 34 ToT programs held in various states covering 922 farmers. Out of this approximately 535 trainer farmers conducted training programs for the job role of Organic Grower (AGR/Q1201) NSQF level: 4.

Teams appointed at Head Quarter

Teams were appointed at the headquarters to facilitate and assist the field teams in registering the farmers on SDMS portal, monitoring, logistics, farmers attending RPLs. Almost 24 Metric ton bio-fertilizers and compost was prepared and distributed among the farmer trainers to apply in one-acre farm labs to be used as demonstrative fields for the RPL farmers and other farmers of surrounding areas.

RPL Trainings

The farmers of the community from which the interested and eligible trainer farmers belonged to were oriented by the scientists (State Coordinators) about the benefits of the trainings being offered by Skill India, National Skill Development Council and Organic Farming. After the orientation, the desired documents including their adhaar card, passport size photos, qualification certificates, Bank account details were collected from the farmers and the data was uploaded on SDMS portal for approval of dates to conduct the RPL training. These trainings facilitated the farmers the technical know-how and the principles of Organic Farming. Since the farmers were on marketing of the produce at premium prices, in a few areas, they were motivated through connecting to some of the Organic produce selling companies.

Training Material

Training manual booklets were prepared by the scientists involved in the project covering the National Occupational Standards (NOS) discussed in Qualification Pack and the Knowledge & Understanding; Performance Criteria and Professional Skills to be developed among the trainees during the training program. Knowledge and Understanding is meant to bring in satisfactory operational learning and comprehension to practice organic farming. Performance Criteria is to pick up the required aptitudes through hands on preparation and play out the required operational inside. While the professional skills are capacity to settle on operational choices as described in facilitator Guide for the Organic Grower developed by ASCI. Training material included pens and registers to make notes, relevant videos on preparing Jeevamrut, vermicompost preparation, seed treatment and motivational recordings of farmers already practicing Organic Farming.

Farmer to Farmer (F2F) Approach

Farmer to Farmer extension approach in agriculture is a systematic utilization of community leadership and informal communication between farmers. In this project, F2F approach has been followed. First the lead farmers were selected who are called model, master, or lead farmers and they are chosen based on good communication skills, literacy, agriculture background, trustworthiness and leadership qualities. The lead farmers then are trained about the approach, the tools, technology and methods including extension methods. They are the first to experiment with the approach on their field. Further they transfer the knowledge and skills to other farmers of the community through model farms (which is named here as "farm lab"), community networks, practical training, etc. The benefits through F2F approach to the farmer include gain of knowledge at minimal cost and high benefits; improved social status among the community due to increased knowledge; increase in social networking; additional income generation through better knowledge; early access to new technology; and "feelings and behavior that show a desire to help other people and lack of selfishness".

Establishment of Farm Labs

Once the farmer trainers agreed to offer 1-acre land for experiments following organic farming practices, those fields were declared as 'Farm Labs'. These Farm Labs are basically experiments maintained by the farmer trainers or lead farmers with the assistance of PBRI scientists. The bio products of PBRI were provided for these farm labs to the farmer trainers free of cost. Each Farm Lab has been marked with Display boards, on which, the name of the farmer trainer and location is mentioned. These farm labs have become the focal points for all the stakeholders including the farmers from the community and PBRI teams.

The main objectives of establishing farm lab are

- To demonstrate methodologies and principles of organic farming to farmers to achieve chemical free agriculture produce by using natural and organic inputs without disturbing environment and eco-friendly research approach.
- To enhance understanding of farmers on critical factors in the selection of crops and cropping patterns.
- To create an understanding on judicious use of natural resources such as soil and water.
- To provide basic awareness on seed and cropping systems.
- To sensitize the farmers on Good Agricultural Practices (GAP).
- The criteria for selecting of trainer farmer for establishing farm lab:
- All trainer farmers who have successfully conducted the first RPL.
- All trainer farmers who have signed the service agreement.
- Trainer farmers interested to conduct the farm labs.
- Trainer farmer willing to take risk of any crop failure etc.

The criteria for exclusion of trainer farmer from the farm lab

- Batch/Location has been cancelled by NSDC and payout to Patanjali is not received.
- No of farmers passed in the farm lab is very low eg <10. In this instance check the data available with you and share your comments.

Selection of farm lab field

- Selection of farm lab field location is a very important step in establishing farm lab demonstration. The below mentioned criteria should be followed for selection.
- The farm lab should be one acre of land.
- The location of farm lab should be easily approachable and good motor able road. Preference should be given to main road side plots which can be seen by many visitors and passersby.
- Avoid problematic soils like eroded lands, rocky lands, sandy soils, saline or alkaline soils.
- Avoid using leased lands for developing farm lab.
- Select reasonably well aerated soil (sandy loams, alluvial, red sandy loams, black soils) with mediocre fertility having pH value 6 to 8.

Farm lab details

Designated Farm Labs will have following;

Sign Board of the Farm Lab

Flex sign board (4'x6') will be provided by State coordinator for chosen farm location. As a rule, sign board should be placed at designated location at farm lab, if farm lab has space issue or other biotic/abiotic issue, in such case sign board can be stored in farmers house. Farm lab images should be documented at critical stage of crop production along with sign board.

- **GPS location of the Farm Lab**

  Location should be recorded properly at FARM LAB APP.

- **Details of crop**

  Crop details (name and variety) should be mentioned in sign board and FARM LAB APP as well.

- **Normal Farmer Practice and PBRI practice.**

  In PBRI practice farm lab, PBRI will provide free PBRI organic inputs to raise crop, whereas farmer will use his own traditional practice in Farmer Practice farm lab. The inputs are to be picked up by concerned Trainer Farmer from nearest pick up location.

  Receipt of PBRI organic inputs need to be signed by farmer and state coordinator after receiving PBRI organic input package.

  Crop production related information of Farmer Practice and PBRI practice should be updated properly in FARM LAB APP by State Coordinators and field staff.

Farm lab operations

- **Field mapping**

  After selection of land for farm lab establishment the location of the lab has to be recorded on PBRI farmers' app.

- **Field preparations**

  The farm equipments (plough, seed drill, sprayer etc.) used for non organic farms has to be cleaned thoroughly before using in farm lab land.

- **Seed**

  It is advisable to use certified seed or seed treated with bio-pesticide or organic materials for sowing. In the absence of varieties, hybrids produced by private seed companies can be used but make sure that seed should not be treated with chemicals.

- **Cultivation of crops**

  In order to maximize the production from the available resources and prevailing climatic conditions, need-based, location specific technology needs to be generated. National agriculture research institutes (ICAR) and state agricultural Universities, Research Institutes, Krishi Vigyan Kendras (KVKs) and agriculture research in private sector have been generating ample technologies to improve the productivity and profitability of the farming in different agro climatic zones. There are 15 agro-climatic zones identified by NARP.

- **The POPs and literature will be shared by state coordinator/field assistant of respective states through Google drive, emails, WhatsApp etc.**

Table 1. LIST OF THE STATES ALONG WITH AGRO CLIMATIC ZONE

S. N.	STATES	AGRO-CLIMATIC ZONES
1.	Andhra Pradesh	Southern Plateau and Hills/ Eastern Coastal Plains and Hills
2.	Bihar	Lower Gangetic Plain Region/ Middle Gangetic Plain Region
3.	Chhattisgarh	Eastern Plateau and Hills
4.	Delhi NCR	Trans-Ganga Plains Region
5.	Gujarat	Gujarat Plains and Hills
6.	Haryana	Trans-Ganga Plains Region
7.	Himachal Pradesh	Western Himalayan Region
8.	Jharkhand	Eastern Plateau and Hills
9.	Karnataka	Southern Plateau and Hills
10.	Madhya Pradesh	Central Plateau and Hills
11.	Maharashtra	Western Plateau and Hills/ Southern Plateau and Hills
12.	Odisha	Eastern Plateau and Hills/ Eastern Coastal Plains and Hills
13.	Punjab	Trans-Ganga Plains Region
14.	Rajasthan	Trans-Ganga Plains Region
15.	Telangana	Southern Plateau and Hills/ Eastern Coastal Plains and Hills
16.	Uttar Pradesh	Middle Gangetic Plain Region/ Upper Gangetic Plains Region
17.	Uttarakhand	Western Himalayan Region/ Upper Gangetic Plains Region
18.	West Bengal	Eastern Himalayan / Lower Gangetic Plain Region
19.	NE Assam	Eastern Himalayan Region

Selection of crops and variety

State Coordinators will facilitate the trainer farmer for proper selection of crop(s) /varieties based on following parameters;

- Past and present experiences of farmers.
- Climatic factors (temperature, rainfall, sunshine hours, relative humidity, wind velocity, wind direction, seasons and agro-ecological situations).
- Soil conditions.
- Cropping system options.
- Testing of organic practice at farmer's field.

Key requirements for improving productivity

State coordination will facilitate the trainer farmer. Increase in productivity and profitability of organic farming can be achieved through:

- Blending practical knowledge with scientific technologies.
- Efficient use of natural resources and natural products.
- Adopting time specific crop management practices.
- Giving priority for quality driven production.
- Adopting suitable farming systems without disturbing nature.
- Adoption of location specific technology and organic materials.
- Market demand driven production.
- Adopting low cost and no cost technology.

Fertility management of organic farms

Soil fertility is fundamental in determining the productivity of all farming systems. Organic farming systems rely on the management of soil organic matter to enhance the chemical, biological, and physical properties of the soil, in order to optimize crop production. A list of resources regarding fertility management in organic farming system is given below;

- A hardcopy of FARMERS TRAINING HANDBOOK will be provided to each and every farmer.
- "GOOGLE DRIVE link contains state-wise POPs and other technical information" will be shared to State coordinators of respective states.

Coping options for trainer farmers

- State Coordinators
- Progressive Farmers
- Agri Clinics and Agribusiness Centers
- KVK and Kissan Call Centers (phone number should be added by State coordinators of respective states).

- Kisan Credit Card Scheme (KCC)
- Agricultural Universities/Agricultural Research Stations
- ICAR Organizations
- Nationalized banks
- Concerned NGOs
- Subsidy schemes of State/Central Governments
- Radio, TV, Agricultural Magazines, Community, Newspapers, Agricultural Websites etc.

Research trials

Experimental designs

Treatment 1: Normal practices by Farmers.

Treatment 2: Cultivation using Organic Bio products supplied by Patanjali Bio Research Institute (PBRI).

Plot size: Gross plot area- 4000 Sq. Mt. each (1/4th for hills)

Observation need to be recorded

The observations that are to be recorded given below:

- Crop specific Agro morphological observations at critical growth stages, Yield & Yield parameters and, scoring for pests and diseases- DATA WILL BE COLLECTED THROUGH APP (Table 2).
- Plant Height (cm), Plant canopy, Productive tillers/plant, Seed Yield/Plant, Test weight, Harvest index, Plot Yield, Germination percentage and seed vigor- DATA WILL BE COLLECTED THROUGH APP.
- Nutritional Profiling and Shelf life. Nutritional value of crop produce: Calcium, Protein, Zinc, and Iron- SELECTED CROPS WILL BE EVALUATED FOR NUTRITIONAL PROFILING in few locations only.
- Soil sampling and analysis (NPK, Soil texture, Micronutrients, Soil Microbes) before planting and after harvest; DATA WILL BE COLLECTED THROUGH APP.
    - Bacterial, Fungal and actinomycetes population enumeration in soil.
    - Soil Microbial biomass carbon and nitrogen.
    - Soil enzymes − Dehydrogenase, glucosidase and phosphatase (indicative of total microbial activity, carbon cycling and phosphorus cycling) IN FEW LOCATIONS ONLY.
    - Weekly weather parameters like RH (%), Min and Max temperature, Sunshine hours and total rainfall- WEATHER DATA WILL COLLECT THROUGH KVKs OF EACH LOCATION.

Table 2. FORMAT FOR COLLECTING FARM LAB DATA

FARM LAB DATA COLLECTION		
PERSONAL DETAILS		
Farmers name		
D.O.B		
Aadhar card no.		
Address		
Crop Information	**Farmer practice**	**PBRI practice**
Main crop name & variety		
Sub crop name		
Area (acre)		
Sowing date		
Planting date		
Fertilizer applied		
(name and date)		
Pesticide applied		
(name and date)		
No. of irrigation		
Weed noticed		
Disease observed		
Pest observed		
Other		
Data Collection	**Farmer practice**	**PBRI practice**
Plant height (cm)		
No of productive tiller/plant		
Panicle size (cm)		
No of fruit/plant		
Date of harvesting		
1000 grain weight		
Yield/plant (g/kg)		
Yield/plot (Kg)		
Straw Yield (Kg)		
Byproduct (Kg)		
Crop condition		
General observation		
Farm income (Rs)		
Farm expense (Rs)		

Collection of data

- Background information: previous crop, planting and harvest date, varieties/hybrids used, seeding rate, plant populations at harvest, chemical applications, soil types, and rainfall/irrigation.
- Observations: The data collection depends on research component, example- yield, resistance to pest, bird damage, fertilizer comparison, varietal comparison. We have to take observations as per critical crop stages.
- Data collection through PBRI app
    - State Coordinator/Field assistant will train farmers regarding app related things;
    - App downloading.
    - App installation
    - Understanding the App flow
    - How to do Data entry and saving
    - How to contact PBRI technical support for any query.

Conducting field days by trainer farmer

Since the trainer farmer has successfully conducted the training program, trainer farmer is expected to call/invite the passed/interested farmers in his farm lab at critical stage of crop production and share/discuss the results so far using conventional vs PBRI practices.

Efforts to be made through collective discussion to improve the organic farming practices, and to provide feedback to State coordinator from time to time. Atleast 2 field days per cropping season to be conducted by trainer farmer, and facilitated by state coordinator/field staff.

RESULTS

After gathering harvest data, it needs to be analyzed to compare with control trial. If the trial was set up using replication and randomization, statistical tools can be used to determine if there are real differences between the treatments. Using statistics to analyze the data will allow you to have confidence in your results and help you determine if you would get similar results in another field or year.

- Analysis of data based on crop.
- Analysis of data based on different agro-climatic zones.
- Documentation of farm lab data results in a report.

PBRI procedures for farm lab development

- Start with soil testing for pH, organic matter and NPK.
- Application of 5 tons/acre FYM before sowing.
- Again application of Patanjali Jaivik Khad 40 kg/acre (before sowing).
- Application of Patanjali Jaivik PROM 80 kg/acre at the time of sowing.

- Seed treatment with Patanjali Bio NPK, Patanjali Tricho and Patanjali Fluorescens 10g/ml/kg seed for 30min and drying under shade for 30 min before sowing.
- Dipping of seedlings in the solution of 5-10 ml/gm/litre water for 30 minute than transplant.
- Nursery treatment by mixing with Patanjali Subhumi/Poshak 1 kg per acre required nursery.
- After 30 days of sowing, Patanjali Subhumi/Poshak 5kg/ acre to be mixed with 50 kg of soil and spread into the field.
- After 45 days of sowing apply 1kg/acre Patanjali Tricho/Patanjali Suraksha and Patanjali Fluorescens.
- As per the requirement application of biofertilizers 500 ml/acre for soil treatment and 5-10 ml per kg seed to be taken up.
- For Nitrogen, application of either one of the following as per the crop
    - Patanjali Azoto plus (Azotobacter chroococcum) for cereals and horticultural crops
    - Patanjali Rhizo plus (Rhizobium sp) for pulse crops
- For Phosphorous, application of Patanjali PSB Plus (Bacillus megatherium, Bacillus polymixa, Pseudomonas striata, Pseudomonas rathonis) as they consists of Malic acid, Citric acid, Gibberellic acid, Tortanic acid which will be useful for the healthy growth of plant.
- For Zinc deficiency, application of Patanjali Bio Zinc Plus (Bacillus cereus and Pseudomonas sp.) is useful.
- Patanjali Bio pesticides
    - Patanjali Vati (Verticillium lecanii) for controlling sucking pests and larvae
    - Patanjali Beauveria (Beauveria bassiana) for controlling of larvae of all crops
    - Patanjali Meta (Metarhizium anisopliae) for controlling of white grubs and caterpillars, thrips and termite.
- Patanjali Bio Fungicides:
    - Patanjali Tricho (Trichoderma viride)
    - Patanjali fluorescens (Pseudomonos fluorescens) for controlling root rot, stem rot etc., in most of the crops.
- For controlling Nematodes Patanjali Nemakil (Verticillium chlamydosporium) is used mostly in rainfed/upland crops
- Micronutrients are required throughout the crop growth cycle and are available through Patanjali Jaivik PROM and Patanjali JaivikKhad which are applied during sowing of the crop.
- The Farmers on their own can also prepare some of the organic fertilizers viz., Sanjeevak, Jeevamruth, Beejaamruth, Panchagavya, Vermi compost, Vermi wash, Green manure, Ghan jeevamruth etc.

Role of project team in establishing farm labs

- **Capacity building:**
  - Arrange farmers' training program on improved agronomic practice of selected crops
  - Solution of the farmer problem arises during cultivation i.e. insect-pest management, diseases etc.
  - Knowledge sharing with identified farmers
  - Application of prescribed POPs at farm lab
  - Providing technical support for crop production
  - Technical guidance to farmer for data collection through PBRI app
  - Contact information for technical support
- **Input supply to farmers**
  - Distribution of the inputs to farmers.
  - Trials as per norms given in proposal in one acre.
  - Technical Guidance.
  - Supervise the farm labs.
- **Reporting and documentation**
  - Data record of selected farmers to be uploaded in app.
  - Coordination, evaluation and monitoring of project activities.

Andhra Pradesh

Andhra Pradesh State is "the bejeweled rice bowl of India". Agriculture plays an important role in the livelihoods of people as 63% of the population in Andhra Pradesh live in rural areas and depend on agriculture and related livelihood opportunities. The State of Andhra Pradesh with 13 districts has great potential for agriculture and allied sectors. Out of 12 farm labs established in the state, , 2 in AESR 7.1 (South Telangana Plateau (Rayalaseema) and Eastern Ghat hot, dry semi-arid ESR) with dominantly black soils and LGP – 90-120 days; 4 in AESR 7.2 (North Telangana Plateau hot, moist semi-arid ESR) with dominantly red and black soils with LGP – 120-150 days; 4 are in AESR 7.3 (Eastern Ghat (south) hot, moist semi-arid/ dry sub-humid) with deep well drained calcareous clay soils with LGP – 180-210 days; and one each in AESR 12.1 (Garhjat hills, dandkaranya and eastern ghats hot, moist sub-humid ESR) with deep loamy red and lateritic soils, black soils of Mahanadi basin, poorly to imperfectly drained and LGP – 150-180 days; and AESR 18.3 (Andhra Plain, East cost hot dry sub-humid ESR) with LGP – 150-180 days. AESR 7.1 is agriculturally less developed, AESR 7.2 and 18.3 are agriculturally moderately developed and AESR 7.3 is agriculturally highly developed.

Crop Rotations

The major Kharif crops viz. paddy, maize, jowar, bajra, ragi and pulses are produced in the State known for their rich nutrient content are the staple diet of millions of people. In addition to these crops Pulses like Redgram, Blackgram, Green gram etc., are under cultivation in major extent. Generally in Coastal plains of Andhra Pradesh (under Krishna and Godavari rivers) farmers go for Paddy - Paddy - Pulses/Vegetables in Karif- Rabi- Summer seasons respectively. In uplands (Under Tanks, Borewells) farmers go for Chilli/Cotton/ Turmeric-Maize-Vegetables/Pulses in Karif- Rabi- Summer seasons respectively. Under Rainfed farmers go for Cotton with Red gram (Karif) Millets / Bengal gram (Rabi). Out of 12 farmlabs in the state, 4 were under Paddy, 4 under Red Chilli, and remaining 3 under Sugarcane, Sunflower, Brinjal and Cotton.

Soils & Soil Fertility

There are 6 types of soil found in Andhra Pradesh.1. Red Soil - 65%, 2. Black Soil- 25%, 3. Alluvial Soils - 5%, 4. Costal Sands- 3%, 5. Laterite & Lateritic Soils - 1% and 6. Problem Soils - 1%. The soil testing in 12 farm labs revealed that Phosphorus and Potash are medium to high whereas Nitrogen is medium to high. Organic carbon is ranging between 0.4 to 0.8. The pH in all the farm labs ranged from 6.9 to 7.3. Total 8 one-acre farm labs were having Paddy during the kharif-2019 and were supplied free of cost Prom, Poshak, Jaivik Khad, PSB, KMB, Rhizobium and FYM to apply in the fields and Trichoderma and Pseudomonas to control fungal diseases to all the farm labs.

Adaptation of Organic Farming and Issues

The farmers have started growing crops with organic methods. But still they need proper extension and training on usage of bio-fertilizers and bio-pesticides in the fields. They need to apply bio-fertilizers too based on soil testing report. For indigenous or high yielding varieties, the seed accessibility is an important issue. Under PFSP, the farmer trainers have been motivated to make good networks and search reliable seed companies, from whom they and the farmers who have been trained by them under RPL may get good quality seed of crop varieties in advance before sowing.

Cost of Cultivation and Net Profit

In farm labs under Paddy, the average cost of cultivation was 32,750/- per acre and the net profit was INR 27,500/-. Similarly in farm labs under Red Chilli, the average cost of cultivation was 97,500/- per acre and the net profit was INR 38,500/-. In farm labs under Sugarcane, the cost of cultivation was INR 2,10,000/- and the net profit was INR 90,000/-. In farm labs under brinjal and sunflower are yet to be harvested at the time of report writing. IN farm labs under Cotton, the cost of cultivation was INR 35,000/- and the net profit was INR 19,000/-.

Recommendations

The organic sugarcane and Red Chilli have shown to be high profit fetching crops but some areas are less suitable for sugarcane and some are highly suitable and vice versa for Red chilli. Those areas which are less suitable for sugarcane crop but highly suitable for another crop, here the alternative of these two crops can be suggested based on suitability class of ones' field. Production of Millets (Siri Dhanayalu) in large areas may gain good marketing, as with increasing awareness more people prefer to consume millets instead of rice due to emerging health issues like diabetes, high BP and obesity.

Assam

Out of total 41.6 lakh ha total cropped area, 28.11 lakh ha is net sown with 148% cropping intensity. According to the estimate of 2012-13, total production of total food grains was 52.81 lakh tones from 26.92 lakh ha area. Out of the total 10 farm labs, 5 were in AESR 15.2 (Middle Brahmaputra plain hot humid, LGP – 240-270 days) and 5 were established in AESR 15.3 (Teesta and Lower Brahmaputra plain, hot moist humid to per-humid ESR, LGP – 270-300 days) with moderate development of groundwater (50%), irrigation (37%) and 124.5% cropping intensity.

Crop Rotations

The main crop rotations being followed in these regions were Rice-Toria, Rice-toria-vegetables, Rice-Vegetables, Tea-Banana-Assam Lemon-vegetables mix cropping, Rice Jute-Toria/Brinjal etc.

Soils & Soil Fertility

The well drained, deep acidic alluvial soils of upper Assam with good proportion of Phosphorous are mostly for plantations. Alluvium of the plains offers excellent opportunity for cultivating rice and vegetables. New alluvial soils occurring in charlands of Brahmaputra are most suitable for growing oilseeds, pulses and rabi crops. The soil analysis in the farm labs revealed that the soil was mild acidic in Nalbari and Biswanath district. The other farm labs were mildly alkaline (pH being around 8). Organic carbon was medium to low except at a location at Kazidahar, Cachar, where it was high. Nitrogen was mostly medium, but low in Bamunkura and Khalisatari of Dhubri district. Phosphorus and potash were medium to low. Farmer trainers were supplemented with PROM, Poshak, Jaivik Khad, PSB, KMB, Rhizobium and FYM to be applied in the fields and Trichoderma and Pseudomonas to control fungal diseases. However, due to serious flooding conditions, farmers received the inputs in September 2019.

Adaptation of Organic Farming and Issues

The farmers were already familiar with organic crop production. Their zeal got momentum after 10 days training on Organic Grower at KVK, Kamrup wef.3-11 January,2019. But still theren is need for proper training on usage of bio-fertilizers and bio-pesticides in the fields based on soil testing report. The accessibility to suitable varieties is an important issue of a proper farm lab. Under PFSP, the farmer trainers have been motivated to make good networks and search reliable seed companies, from whom they and the farmers who have been trained by them under RPL may get good quality seed of crop varieties in advance before sowing. However, the marketing of organic products have to be critically reviewed.

Cost of Cultivation and Net Profit

The net profit was maximum in Kazidahar, Cachar (Rs 180,000/-) In farm labs under Rice, Cowpea, livestock, fishery etc. followed by INR. 107,000/ acre at Udalguri with rice, litchi and arecanut and INR 100,000/- in Baksa with Tea, Lemon, Banana, arecanut and livestock. The cost of cultivation was lowest (Rs 10,000) in Bamunkura, Dhubri and the net profit was INR 35,300/- with rice and straw only.

Recommendations

Tea, litchi, areca nut, strawberry and mushroom were seen high profit fetching crops. Rice alone cannot compensate the cost of cultivation. As a thumb rule, legumes like green gram, Black gram Subabul,fodder crop may be included in the system. Integration of components like Dairy, Fishery, Duck farming, Poultry, Piggery, Apiary etc. would be more remunerative.

Bihar

The state of Bihar is covered by 2 AESRs viz., 9.2 (Rohilkhand, Avadh and South Bihar Plains) with deep loamy alluvium-derived soils and LGP – 150-180 days and is agriculturally moderately developed region; AESR 13.1 (North Bihar and Awadh Plains hot dry to moist sub-humid) with deep, loamy alluvium-derived soils and LGP 180-210 days. AESR 13.1 is agriculturally a medium developed region with less developed groundwater and irrigation. A low farmer income and crop output has been observed. Out of total 21 farm labs in the state, 14 are established in AESR 13.1 and 7 are in AESR 9.2.

Crop Rotations

Being a part of Indo-Gangetic plains, Rice-Wheat system is predominant in the state. However, Maize also occupies significant area during kharif. After great efforts from state Govt. and International agencies ,much of the area is replaced by kharif-maize. Pulses like Moong, toor, peas and khesari are primarily grown in southern region of the state covered by AESR 9.2 and vegetables and orchards are covering plenty of area in districts of Muzaffarpur, Patna, Vaishali, Katihar, Begusarai, Nalanda, East & West Champaran.

Soils & Soil Fertility

Soil testing revealed a low to medium status of Nitrogen, Phosphorus and Potash in all the farm labs with pH ranging from 6.5 to 6.8. Soil Organic Carbon was observed 0.5-0.6 in the soils of both AESRs. Paddy was taken in farm labs by the farmer trainers. Most of the farm labs are irrigated by tube wells.

Adaptation of Organic Farming and Issues

Although, the recent alluvial plains of IGP are suitable for rice and climate is also well-suited, the continuous cultivation of rice-wheat has exhausted the ecosystem of soils. The organic carbon has reached to its lowest level. Alternative crops like maize have been promoted and pulses are also taken in the cropping system. North eastern area receives a better rainfall than the south-western region. The awareness among both farmers and the consumers about quality and benefits of organic produce is lacking. A few entrepreneuring farmers could sell their produce directly by developing customer base, but most of the farmers have been struggling to access the customer/market for their premium produce. Those who are trained and are slowly adopting organic farming are confident that very soon the problems of low yield and marketing will be addressed.

Cost of Cultivation and Net Profit

Out of 21, total 18 labs were under paddy and 3 were under Mentha and vegetables. Almost all the labs fetched good profitability to the growers. The cost of cultivation in one-acre paddy fields ranged from INR 8500/- to 11500/- and net profit ranged from INR 4400/- to 8000/-.

Recommendations

Paddy, Mentha and vegetables are well remunerative crops in the region if grown with organic practices. Apart from direct cash profit, the long-term benefits of soil and human health are numerous. Northern part of the state covered in AESR 13.1 is moderately suitable for bengal gram, black gram and green gram. Adoption of one legume after one cereal can be promoted extensively in the region except swampy area of Terai to improve the soil health.

Uttar Pradesh (1)

A total 17 farm labs are established in Western and Central Uttar Pradesh. Out of which 6 are established in AESR 4.1 (North Punjab plain, Ganga-Yamuna Doab and Rajasthan uplands) with deep loamy alluvium derived soils (occasional saline and sodic phases) and LGP – 90-120 days; 7 in AESR 9.1 (Punjab and Rohilkhand plains) with deep, loamy to clayey alluvium derived (inclusion of saline and sodic phases) soils and LGP – 90-120 days; 4 in AESR 9.2 (Rohilkhand, Avadh and South Bihar plains) deep loamy alluvium-derived soils and LGP – 150-180 days.

Crop Rotations

State of Uttar Pradesh is in Indo-Gangetic plains where Rice-Wheat system is dominant. Although, sugarcane is covering highest acreage in the country. Oilseeds, pulses, horticulture (mango) and vegetables are also grown widely. In Kharif season, the sowing of the crops starts in the month May and harvested in the month of October-November. Whereas, in Rabi season the sowing of the crops starts from the month of October and harvesting in the month of March-April in the state.

Soil & Soil Fertility

Six well defined and distinct soil groups differing from one another in their Geological formation and pedogenic characters have been recognized. These are Bhabar soils, Tarai soils, Vindhyan soils, Bundelkhand soils, Aravali soils and Alluvial soils. The major coverage of alluvial soil in further grouped as saline-alkaline soils, Karail soils and Bhatt soils. Again, saline-alkaline soils are divided in three groups i.e. Saline soils, Saline alkaline soils and alkali soils.

Soil testing of farm labs revealed that available Nitrogen and phosphorus are medium, and Potassium is high. The pH ranged from 6.5 to 6.8 and soil organic carbon ranged from 0.5 to 0.6 (low). All the farm labs were supplied free of cost bio fertilizers, Trichoderma and pseudomonas.

Cost of Cultivation and Net Profit

Out of 17 farm labs, 13 were under paddy, 3 were under pearl millet and one was under black gram. In 5 farm labs in eastern plains the average cost of paddy cultivation was INR 22,495/- per acre while the average net profit was INR 15,085/- only. Whereas in western plains, in 6 farm labs the average cost of cultivation for paddy was INR 24,107/- and the average net profit was INR 13,339/-. In 3 farm labs in central western plains, the average cost of cultivation for pearl millet was INR 11,033/- per acre and the average net profit was INR 9,300/-. At Amroha the lone farm lab under black gram showed a cost of cultivation of INR 8,000/- per acre and the profit was INR 37,000/-. Pulses and oilseeds give higher returns in cash as well as benefited the soil ecosystem.

Adoption of Organic Farming and Issues

The western plain has medium to large size land holdings while the eastern plains has mostly small land holdings. The farmers have the curiosity about increment in returns and soil health while adopting the organic farming practices but there is a fear of lesser yields during the initial years. They hesitate to take the risk. Through trainings and continuous motivation, they come were convinced. The grain markets are the only organized way to sell farmers' produce. And those markets have no room for organic good quality produce for premium price. However, the smart farmers who have networking skills could sell their produce through networking. There is less awareness about certification process (PGS). Through skill trainings, now they are being taught about necessity of certification.

Recommendation

More trainings through skill development program and cluster formation approach, community based organic farming in potential areas where the land holding size is small, will work effective. To make the efforts more effective, input supply (organic fertilizers and seed) worked very well. Additional efforts like FPO/FPC formation after the cluster formation and fastened certification process will bring more farmers to practice organic/natural farming.

BUNDELKHAND JHANSI –UP-2

All 57 farm labs of Bundelkhand region are covered in AESR (4.4) Madhya Bharat Plateau and Bundelkhand uplands) with deep loamy and clayey mixed red and black soils. This region covering 8.38 million ha. geographic area is agriculturally a highly developed AESR with LGP − 90-120 days. Bundelkhand region is a draught prone region receiving deficient rainfall hence, water scarcity is there most of the years. The farm labs are established in the basin of Betwa river and most of the area is irrigated.

Crop Rotations

The main crop rotations being followed in Bundelkhand regions are Black Gram, Green Gram, Groundnut, Tulsi/ Wheat/Gram /Quinoa, Chamomile Ashwagandha. kharif crops are sown in June and are harvested since October to February based on maturity. Rabi crops are sown in the months of October and November, which are harvested in February and March. Out of 57 farm labs in Bundelkhand Jhansi 8 were under Black gram, 2 under Green gram, 22 under Groundnut, 16 under Tulsi, 9 under White Sesame.

Soils & Soil Fertility

The soil testing in these farm labs revealed low to medium available Nitrogen, low Phosphorus and high Potash. Organic carbon is ranging between 0.4 to 0.6. The pH in all the farm labs ranged from 6.2 to 7.5. All the farm labs were supplied free of cost Prom, Poshak, Jaivik Khad, PSB, KMB, Rhizobium and FYM to apply in the fields and Trichoderma and Pseudomonas to control fungal diseases.

Adaptation of Organic Farming and Issues

The farmers have started growing crops with organic methods. But still they need proper extension and training on usage of bio-fertilizers and bio-pesticides in the fields. They need to apply bio-fertilizers based on soil testing report. For indigenous or high yielding varieties, the seed accessibility is an important issue. Under PFSP, the farmer trainers have been motivated to make good networks and search reliable seed companies, from whom they and the farmers who have been trained by them under RPL may get good quality seed of crop varieties in advance before sowing.

Cost of Cultivation and Net Profit

In farm labs under Tulsi, the average cost of cultivation was 7500/- per acre and the net profit was INR 19500/-. In farm labs under Black gram, the cost of cultivation was INR 8500/- and the net profit was INR 15,500/-. In farm labs under Green gram, the cost of cultivation was INR 8500/- and the net profit was INR 15,500/-. In farm labs under Groundnut the cost of cultivation was INR 11500/- and the net profit was INR17000/- In farm labs under White Sesame. The cost of cultivation was INR 8000/- and the net profit was INR 17,500/- Almost all the three crops fetched >150% net profit and enhanced the income of the farmer to more than double.

Recommendations

Bundelkhand area is known for its water problem and harsh climate. Farmers here need draught resistant crops types. Farmers should be promoted with indigenous varieties of crops which can survive in such harsh environment such as “Khatiya Genhu, white sesame. Medicinal crops also turn to be profitable venture for farmers crops like Tulsi, Chamomile and Quinoa are highly demanded crops and have become priority for farmers. Crops like soybean and groundnut can be replaced by tulsi, white musli, ashwagandha in kharif and Quinoa, Chamomile, Chia, mustard, lentil could be alternative crop for wheat in rabi. Animal husbandry also plays important role as one of the sources of farmer income in Bundelkhand region. Integrated farming systems with improved water use efficiency could be the most effective ways to adapt to climate change in the region.

Uttarakhand and Himachal

In Uttarakhand 12 and in Himachal 5 farm labs are established. Out of 12 in Uttarakhand and all 5 of Himachal are in AESR 14.2 (South Kashmir and Kumaon Himalayas warm moist to dry sub-humid transitional ESR) with medium to deep loamy to clayey brown forest and podzolic soils and LGP – 150-210 days. Remaining 6 farm labs of Uttarakhand are in AESR 14.5 (Foothills of Kumaon Himalayas (subdued) warm moist sub-humid ESR) with medium to deep loamy Tarai soils and LGP – 270-300 days.

Crop Rotation

In the hill soils, cash crops (onion and ginger), small millets and pulses (barley, gahat, bhatt (black soybean), soybean, ragi, amaranth, rajma (kidney bean), horse gram, pigeon pea and barnyard millet (sawa) are grown. In Tarai soils, Rice-wheat/sugarcane are grown as major crops. Vegetables are also grown in hills.

wheat, maize, rice, and barley are the main cereals cultivated in Himachal Pradesh. Kangra, Mandi districts and to some extent Paonta valley of Sirmaur district are the major producers of wheat, maize, and rice. Barley is cultivated largely in Shimla district of Himachal Pradesh. Horticulture (apple) is well developed in the hill soils of state. Potato and some other vegetables are grown, which fetch a high return. Wheat is mainly a rabi crop but is also grown in summer (April-May to Sept.-Oct.) in Kinnaur, Lahaul & Spiti, Pangi and Bharmour.

Soils and Soil Fertility

The hill brown forest soils are acidic Alfisols with low pH moderately deep to deep well drained soils. The Organic matter is very high. Imperfectly to poorly drained and moderately well to well drained at places Tarai soils are mostly neutral Mollisols with high organic matter and considered most fertile soils of the world. In Terai of Northern India (foothills of Kumaon Himalaya) mostly Aquolls and Udolls great groups are found, which remain wet more than 90 days in a year. These soils support rice -wheat system. In farm labs of Hills soils of Uttarakhand, the soil testing revealed low Potash and medium Nitrogen and Phosphorus. Whereas, the in farmlabs of Himachal Pradesh, not only Nitrogen and Phosphorus but Potash was also medium. In Terai soils, NPK levels were medium. Organic matter content was observed 0.5-0.7 in all the farm labs. Although the pH was slightly acidic.

In Himachal, out of 5 farm labs, in 4 NPK was observed medium and in one from Una, NPK was low. Organic carbon was 1.2-1.3 in Kullu and 0.9 in Kangra. The pH was slightly acidic ranging from 6.2 to 6.8.

Adoption of Organic Farming and Issues

In Uttarakhand, on hills most of the cultivation is by default organic. Uttarakhand Organic Commodity Board already made tremendous efforts to promote organic practices in rainfed agriculture of hills. In Tarai plain districts of the state, Udham Singh nagar and part of Nainital; and Haridwar alluvial soils, rice- wheat system is followed which is mostly high input based. All the farm labs were supplied free of cost PROM, Poshak, PSB, KMB, Metarhizium, Trichoderma and Pseudomonas. Some farmers practice organic but marketing of the produce at a premium price has emerged as an important issue.

Cost of Cultivation and Net Profit

In Uttarakhand, out of 12 farm labs, 10 were under paddy in plains for which the average cost of cultivation was INR 12,832/- per acre and the average net profit was INR 13670/-. In one farm lab from Haldwani

(Nainital), Tilak Chandan was grown with a cost of cultivation INR 13,940/- per acre and the farmer could sell the produce (10 qtls) directly with a premium price fetching him the net profit INR 90,000/-. Similarly, another farmer from Roorkee could get a premium price for 10 qtls produce and earned INR 65,600/- net profit. One farm lab under capsicum fetched net profit INR 5,900/- with a cost of cultivation INR 3,100/-.

In Himachal Pradesh, out of 5 farm labs, 2 were under vegetables viz., tomato and peas; 2 were under maize and one was under paddy. The average cost of cultivation for tomato was INR 4,750/- and the average net profit was INR 72,000/-. In case of paddy, the cost of cultivation was INR 15,000/- and the net profit was INR 25,000/-. Maize couldn't give a higher profit (INR 3500/- per acre) with a cost of cultivation INR 1,000/-.

Recommendations

Connectivity to customer and direct selling is working to some extent. More in depth knowledge about organic farming, certification, marketing is desired. Promoting organic horticulture is giving higher returns in terms of cash and benefits to soil health. Particularly, apple in Himachal and vegetables in both the states can be promoted.

TRAINER FARMER	CROP	GRAIN YIELD (Q/ ACRE)	REMARKS	PRICE/ Q	GROSS INCOME (RS)	COST OF CULTIVATION (RS)	NET INCOME (RS)
ANIL KUMAR	MAIZE	1.5	LOSS	1000	1500	3000	-1500
VIRENDER SINGH	TOMATO	21	PROFIT	3500	73500	4500	69000
RAGHUVIR SINGH	PADDY	18	PROFIT	2223	40000	15000	25000
GULBADAN	TOMATO, PEAS	23	PROFIT	3479	80000	5000	75000
SHARBAN LAL	MAIZE	3	PROFIT	1500	4500	1000	3500

Constraints of Farming in Uttrakhand-

Hill agriculture has some inherent constraints of remoteness and inaccessibility, marginality and fragility in terms of moisture stress and the poor soil conditions and a short growing season. Added to these are socio-economic constraints such as small holdings, poor productivity, poor production management, labour shortages, poor post-production management, poor marketing and networks and lack of entrepreneurship. All these have led to under-utilisation of resource bases in the hills and limited generation of surpluses.

Uttarakhand is primarily a mountainous state with only about ten percent of its total geographical area in the plains. Of the thirteen districts, Haridwar, Udham Singh Nagar and some parts of Dehradun and Nainital districts are in the plains, while the remaining areas of the state are hilly. Further, with more than three-fourths (78 percent) of its total population dependent on agriculture for livelihood, the economy of Uttarakhand is predominantly dependent on mountain agriculture. However, the scope for agricultural policies based on modern input-intensive agriculture is severely constrained in the hilly regions of this state due to various physical, geographical and environmental problems.

This has resulted in the majority of the rural population in the hills either surviving on subsistence agriculture or migrating to other parts of the country for employment. In the face of such economic backwardness in the rural mountainous areas of the state, generating remunerative livelihoods in these areas is the only way to fulfil the objective of pursuing an inclusive growth strategy in Uttarakhand.

Delhi NCR (Delhi National Capital Region)

Delhi NCR consist Union Territory of Delhi and following surrounding districts of Haryana and Uttar – Sonipat, Faridabad, Palwal (Haryana) and Gautam Budh Nagar, Ghaiziabad, Meetut, Hapur (Uttar Pradesh). Out of total 23 farm labs, 22 are established in AESR 4.1 (North Gujarat Plain, including Aravalli range and east Rajasthan uplands) with deep loamy grey brown and alluvium derived soils (including sodic phase) and LGP – 90-120 days. Only one farm lab in Meerut is established in AESR 9.1 (Punjab and Rohilkhand Plains) with deep, loamy to clayey alluvium derived (inclusion of saline and sodic phases) soils and LGP – 90-120 days. Both the AESR are agriculturally highly developed with >160% cropping intensity, 98% groundwater development with very high crop output and farmer income.

Crop Rotations

Rice-wheat crop rotation covers about 80% area in the region. Though, this area is not ecologically suitable for rice cultivation, however, rice was introduced in late sixties to achieve food security of the country. There are several options to replace rice crop in Haryana. However, such optional crops need to be made as remunerative as rice crop through improvement in productivity and policy support. The alternative crops which have the potential to replace rice in kharif season are maize, moong/urad, pigeonpea (short duration), soybean, fruits, vegetables and agroforestry. In rabi season, wheat is the main crop which may also be replaced with mustard, bengal gram, lentil, barley etc.

Soils & Soil Fertility

Alluvial soil - a fine-grained fertile soil deposited by water flowing over flood plains or in river beds, alluvial deposit, alluvial sediment, alluvium, alluvion - clay or silt or gravel carried by rushing streams and deposited where the stream slows down. There is wide range of soil texture from sandy to clay loam. Degradation of soil (soil compaction, soil salinity, sodicity, water logging, and pesticide residue), multiple nutrient deficiency, low organic carbon content and decline in the total factor productivity have been observed under different production systems in the State.

The soil testing in these farm labs revealed that Potassium is medium to high whereas, nitrogen and phosphorus are low to medium. Organic carbon is ranging between 0.5 to 0.6. The pH in all the farm labs ranged from 7.6 to 8.1 (Slightly alkaline). Paddy (Basmati) was grown in all the one-acre farms during the kharif-2019 and were supplied with free of cost PROM, Poshak, Jaivik Khad, PSB, KMB, Rhizobium and FYM to apply in the fields and Trichoderma and Pseudomonas to control fungal diseases.

Adaptation of Organic Farming and Issues

The farmers have started growing crops with organic methods. But still they need proper extension and training on usage of bio-fertilizers and bio-pesticides in the fields. They need to apply bio-fertilizers based on soil testing report. For indigenous or high yielding varieties, the seed accessibility is an important issue. Under PFSP, the farmer trainers have been motivated to make good networks and search reliable seed companies from whom they and the farmers who have been trained by them under RPL may get good quality seed of crop varieties in advance before sowing.

Cost of Cultivation and Net Profit

In farm labs from western Uttar Pradesh under Paddy, the average cost of cultivation was 19,166/- per acre and the net profit was INR 19,104/-. In farm labs from Delhi and outskirts, the cost of cultivation was INR 13,618/- and the net profit was INR19,540/-.

Recommendations

Both Paddy and Bajra are high profit fetching crops. However, the adoption of some leguminous crops along with Vegetable in suitable crop rotation with help in improving soil fertility and profitability to farmers. Farmers after receiving organic cultivation training have started adopting appropriate crop rotations. More RPL batches can be trained to increase the awareness and motivation.

Jharkhand

Jharkhand state is covered in four AESRs. Major area is covered by AESR 11 (Moderately to gently sloping Chhattisgarh/Mahanadi Basin) with black, red and yellow sandy loam soils and 150-180 days LGP; and AESR 12.3 (Garjat Hills, Chhota Nagpur Plateau, and Garjat Hills hot, dry sub humid) with moderately deep loamy to clayey red and lateritic soils and LGP – 150-180 days. Both are agriculturally less developed AESRs with low crop output, cropping intensity, farm income and low groundwater development. Out of 25 farm labs, 21 are established in these two AESRs. Remaining 4 farm labs are in AESR 13.1 (North Bihar and Avadh plains, hot dry to moist sub-humid transitional ESR) with deep loamy alluvium derived soils and LGP - 180-210 days. This AESR is agriculturally medium developed with low farm income, crop output and cropping intensity.

Crop Rotations

Paddy-potato/wheat is the main crop rotation in the state. Only 10-11% area of total cultivated area is irrigated in the state and rest of the area is rainfed. During the last two decades, the area under cereals has declined mainly due to decline in the area under paddy. Although, the area under wheat and maize has increased markedly. Area under oilseeds and pulses has also increased but gram, arhar and lentils are not adopted in much area due to low productivity and returns. However, the area under vegetable has increased more than 30% and the technological interventions have improved agriculture in the state. The state receives 1300 mm mean annual rainfall.

Soils & Soil Fertility

The soils of the area where most of the farm labs are established, are Alfisols with low pH (Acidic) followed by Entisols and Inceptisols with pH ranging from 6.5 to 7.5. The districts of Giridih, Ranchi, Dhanbad, Hazaribagh the soils have medium to low available Nitrogen, almost low phosphorus and low Potash levels. The soil organic carbon is observed as low as 0.5-0.6 in the areas under paddy. The soils are rich in micronutrients. 4 farmlabs in Deoghar district and AESR 13.1 have medium range of available Nitrogen and Phosphorus but high Potash. The micronutrient staus is also high except copper. The soil organic carbon is low in the AESR.

Adaptation of Organic Farming and Issues

Farmers have started organic farming practices after the training. But more information on indigenous seed availability and bio-fertilizers availability is required. The latest experience realized that if seed and biofertilizers are offered to the farmers with some advise, the farmers are keen to adopt organic farming. The availability of labor is of course an emerging issue as Organic farming practices require more labor than conventional one.

Cost of Cultivation and Net Profit

All the farmer trainers grew paddy hybrids and fetched a high yield (13 – 22.5 qtls/acre) and good profit from the crop. One farmer trainer fetched INR 30,500/- profit by growing okra in farm lab and selling the produce directly to the customer.

Recommendations

Organic farming is recommended for the farmers in rainfed area in the state with some support of inputs like seed and bio-fertilizers through National scheme or state organic policy. More mechanization by developing and supplying low cost implements may help the farmers to address the labor issue. More efforts can be made to promote organic farming by making clusters and self-help groups.

Karnataka

The agricultural sector of Karnataka is characterized by vast steppes of drought- prone region and sporadic patches of irrigated area. 11 farm labs are established under AESR 6.4 (North Sahyadris and Western Karnataka Plateau: hot, dry, sub-humid ESR) with well drained red loamy soils and imperfectly drained black soils (Calcareous) and LGP – 150-180 days. One farm lab is AESR 19.2 (Central and South Sahyadris: hot, moist, sub-humid transitional ESR) with deep loamy to clayey red and lateritic soils and LGP – 210-270 days. One each in AESR 3 (Karnataka Plateau (Rayalaseema included) with well drained black soils and red loamy soils and LGP – 90-120 days; and AESR 6.1 (South Western Maharashtra and North Karnataka Plateau: dry semi-arid ESR) with shallow to medium loamy black soils (deep clayey black soils as inclusion) and LGP – 120-150 days. AESR 6.4 and 19.2 are agriculturally, highly developed with >80 groundwater development, >65% irrigation, >160% cropping intensity, high crop output and farmers income. AESR 6.1 and 3 are moderately developed with 50% groundwater development, almost 37% irrigation, 125% cropping intensity, moderate farmers income and crop output.

Crop Rotations

In the state of Karnataka wide range of crops are grown with crop rotation. Rice-Vegetables, Rice-Maize and Rice - Bengal gram crop rotation covers about 60% area and another 40% of the area is covered by Sugarcane in the Belgaum district. In Bijapur district from 1960s there was a practice to grow Sunflower - Sorghum, Maize - Sorghum, and Millets - Sorghum crop rotation, but from 2010 more than 70% of the cultivable area is covered with Pigeon pea & inter cropped with Bajra. In irrigated belts like Tungabhadra, Krishna, and KRS, Rice is the main crop in Kharif and Rabi. Finger millet-soybean, Pearl millet - Moong, Foxtail millet - Moong and Millet-Vegetables are the crop rotation followed in Bangalore rural, Hassan, and Kolar districts. Arecanut inter cropped with Legumes, Arecanut inter crop with Green leaf manure, Arecanut inter crop with Cocoa, Arecanut inter cropped with Banana, Arecanut inter cropped with Cardamom, Arecanut inter cropped with Coconut are the major inter cropping practice in the area like Uttara Kannada, Chicmaglur, Shimoga, Mangalore, Udupi, Chitradurga districts. Chilli - Soybean, Chilli - Moong, Chilli - Urad and Chilli - Onion are the crop rotation followed in Dharwad, Gadag and Bagalkot districts. Out of 16 farm labs in Karnataka, 15 were under Paddy, and 1 under banana.

Soils & Soil Fertility

The common types of soil groups found in Karnataka are: Red soils: Red gravelly loam soil, Red loam soil, Red gravelly clay soil, Red clay soil. Black cotton soil: gravelly soil, loose, black soil, basalt deposits. Lateritic soils: Lateritic gravelly soil, Lateritic soil. Degradation of soil (soil compaction, soil salinity, sodicity, water logging, and pesticide residue), multiple nutrient deficiency, low organic carbon content and decline in the total factor productivity have been observed under different production systems in the State. The soil pH in state varies from 6.5 to 8.2. As far as soil fertility in the state is concern, the organic carbon was found to be low, NPK medium in most of the locations.

The soil testing in 15 farm labs revealed that Nitrogen, Phosphorus and Potash are low to high. Organic carbon is ranging between 0.4 to 0.7. The pH in all the farm labs ranged from 6.2 to 7.8. All the 16 farm labs during the Kharif-2019, Bio-fertilizers and pesticides like PROM, Poshak, Jaivik Khad, PSB, KMB, Rhizobium and FYM to apply in the fields and Trichoderma and Pseudomonas to control fungal diseases were supplied at free of cost.

Adaptation of Organic Farming and Issues

The farmers have started growing crops with organic methods. But still they need proper extension and training on usage of bio-fertilizers and bio-pesticides in the fields. They need to apply bio-fertilizers too based on soil testing report. For indigenous or high yielding varieties, the seed accessibility is an important issue. Under PFSP, the farmer trainers have been motivated to make good networks and search reliable seed companies, from whom they and the farmers who have been trained by them under RPL may get good quality seed of crop varieties in advance before sowing. The areas with high groundwater development and irrigation development may be considered in later phases. Moderately developed areas can be given priority for soil health improvement and raise in income.

Cost of Cultivation and Net Profit

In farm labs under Paddy crop, the average cost of cultivation was 40,321/- per acre and the net profit was INR 53,472/-. In farm labs under Banana, the cost of cultivation was INR 84,250/- and the net profit was INR 76,750/-. Horticulture is giving fairly high returns while improving the soil ecosystem.

Recommendations

Both Paddy and Banana crops are high profit fetching crops as per the present study. Some areas are less suitable for Banana but are highly suitable for Paddy and vice versa. Those areas which are less suitable for one crop but highly suitable for another, the alternative of these two can be suggested based on suitability class of one's field. In organic farming vegetables production is more profitable then fields crops. Crops grown like cereals in Kharif season should be followed by crop rotation with Pulses (green gram/ black gram, Pigeon pea, soybean) and vegetables in Rabi season which improvement in productivity and support prices.

In organic farming, weed management is very important, before sowing plough the land and see there is no weeds followed by hand weeding. Bio fertilizers should be applied on the basis of soil test report. Timely supply or make availability of Bio fertilizer and Bio pesticides to the farmers. The organic growers should make efforts to sale their product through self marketing by using mass media, social media, internet, personal contacts for advertisement and by opening organic food specially shop in the residential areas of well-educated group. Good quality seed of newly released varieties should be made available to the farmers.

Maharashtra (Marathwada & Konkan)

A total 17 farm labs are established in Marathwada and Konkan region of the state. 16 out of 17 farm labs are in AESR 6.2 Central and Western Maharashtra Plateau and North Karnataka Plateau and North Telangana Plateau, hot moist, semi-arid ESR) with medium loamy to red and clayey black soils and LGP – 120-150 days. This ESR is agriculturally moderately developed with 37% irrigation coverage, 50% groundwater development, 124.5% cropping intensity and moderately high crop output and farmers' income; Only one farm lab is established in AESR 6.4 (North Sahyadris and Western Karnataka Plateau, hot-dry sub humid ESR) with red loamy soils well drained and black soils and LGP – 150-180 days. This is also agriculturally a highly developed AESR with 64% irrigation coverage, 80% groundwater development, 150% cropping intensity and high crop output and farmer income.

Crop Rotations

80% of Marathwada region follows Rice-wheat cropping system. However, cotton, maize, sorghum, pigeon pea and pearl millet are grown in kharif in considerable area. Grapes, Banana among fruits and in vegetables; pigeon pea, moong, black gram among the pulses; soybean and groundnut among the oilseeds are grown in the region. Many farmers have been fetching higher returns by growing fruits. In kharif season, the sowing of the crops starts in the month June –July based on the onset of monsoon and the crops are harvested in the month of October – November. In rabi season, the sowing the crops starts from the month of October and harvesting is done in the month of January-March based on the crop calendar and maturity.

Soils & Soil Fertility

Deep medium black soils cover the major area of the region, which are rich in plant nutrients supporting growth of both rabi and kharif crops sorghum, pearl millet, wheat, rice, pulses, cotton, sugarcane and groundnut. Soil testing of farm labs in the region revealed low to medium levels of available Nitrogen and medium to high Phosphorus and Potassium. Soil Organic carbon was observed very low ranging from 0.3 to 0.5 in farm labs under cereal crops. The values were

Adaptation of Organic Farming and Issues

Only 16% area out of net sown area is irrigated in the region. The region received a low annual rainfall ranging 600-700 mm. Remaining area is rainfed and suitable for pulses and fruits (Horticulture). Water management is a major issue in black cotton soils. Drip irrigation technology helped the farmers. The area is uneven and plateau region. The region is suitable for organic farming and farmers have adopted the climate smart technologies very well. Higher labor cost, little lower yield initially, good quality seed availability and marketing are major issues for the farmers adopting organic farming.

Cost of cultivation and net Profit

The farm labs were under cotton and groundnut. The farm labs under cotton from Aurangabad and Parbhani could get lower profit (< INR 22,000 to INR 25,000) in comparison to the farm labs from Nanded which fetched >INR 45,000/- Whereas the cost of cultivation ranged from INR 17,000/- to 26,000/-. Pearl millet and Soybean couldn't fetch much profit during the last kharif due to damage caused by excessive rainfall received in the district of Parbhani and Jalna.

Recommendation

Seed availability to the organic growers, FPO/FPC formation and connecting them through networking may help in resolving the issue of marketing. Some of the states are coming forward to provide shops to the FPOs in grain/fruit markets. This will help in increasing the awareness among the customer and a confidence building process among the organic growers. Developing low cost implements may help in mechanization and will resolve the labor issues.

Maharastra (Vidarbha)

The Vidarbha region of Maharashtra has 11 districts which are covered by 4 Agro Eco-subregions. AESR 12.1 (Garjat Hills, Dandkaranya and Easter) and AESR 10.4 (Satpura Range and Wainganga Valley) are agriculturally least developed regions. AESR 12.1 covering 14.9 million ha. area, has deep loamy red and laterite soils, and Black soils of Mahanadi basin, which are poorly to imperfectly drained. The LGP of the region is 150-180 days. AESR 10.4 covering 5.29 million ha. geographic area has Deep to very deep, well drained soils with moderate slight erosion, cracking clay black soils. LGP of the region is 180-210 days. AESR 6.3 (Eastern Maharashtra Plateau, Hot moist) and 10.2 (Satpura Eastern Maharashtra) which are agriculturally medium developed regions with LGP – 120-150 days, 127% cropping intensity, 34% irrigation coverage and low farmer income.

Crop Rotations

The main crop rotations being followed in these regions are Cotton - Groundnut / Summer vegetable / Fodder, Soybean - Wheat/Gram – Fodder, Rice - Wheat/Gram. The kharif crops are sown in June and the crops are harvested since October to February based on maturity. Rabi crops are sown in the months of October and November, which are harvested in February and March. Out of 23 farmlabs in Vidarbha, 5 were under cotton, 5 under soybean, 5 under pigeonpea, 4 under sorghum, one each under blackgram and pearlmillet and 2 under maize.

Soils & Soil Fertility

The soil testing in these farm labs revealed that Phosphorus and Potash are medium to high whereas, Nitrogen is low to medium. Organic carbon is ranging between 0.4 to 0.6. The pH in all the farm labs ranged from 6.2 to 7.5. one third of the one-acre farm labs were having Soybean during the kharif-2019 and were supplied free of cost PROM, Poshak, Jaivik Khad, PSB, KMB, Rhizobium and FYM to apply in the fields and Trichoderma and Pseudomonas to control fungal diseases.

Adaptation of Organic Farming and Issues

The farmers have started growing crops with organic methods. But still they need proper extension and training on usage of bio-fertilizers and bio-pesticides in the fields. They need to apply bio-fertilizers based on soil testing report. For indigenous or high yielding varieties, the seed accessibility is an important issue. Under PFSP, the farmer trainers have been motivated to make good networks and search reliable seed companies, from whom they and the farmers who have been trained by them under RPL may get good quality seed of crop varieties in advance before sowing.

Cost of Cultivation and Net Profit

In farm labs under cotton, the average cost of cultivation was 22,480/- per acre and the net profit was INR 20,900/-. In farm labs under Soybean, the cost of cultivation was INR 14,937/- and the net profit was INR10,237/-. In farm labs under pigeon pea are yet to be harvested at the time of report writing. IN farm labs under sorghum, the cost of cultivation was INR 10,437/- and the net profit was INR 10,987/-.

Recommendations

Both cotton and soybean are high profit fetching crops. Some areas are less suitable for cotton but are highly suitable for soybean and vice versa. Those areas which are less suitable for one crop but highly suitable for another, the alternative of these two can be suggested based on suitability class of ones' field. If a high rainfall prediction is there during a particular year, legumes like soybean may be avoided. Much of the area is rainfed in the region and in case of low rainfall prediction, the small water ponds could be developed to harvest the rainwater and utilize for rabi crops.

Haryana and Punjab

The state of Haryana and Punjab are covered by 4 AESRs viz., AESR 2.3 (Rajasthan Bagar, North Gujarat Plain and South-Western Punjab Plain) with deep, loamy desert soils; AESR 4.1 (North Punjab Plain, Ganga-Yamuna Doab and Rajasthan Uplands) with deep loamy alluvium derived soils and LGP – 90-120 days; AESR 9.1 (Punjab and Rohilkhand Plains) with deep loamy to clayey alluvium derived soils and LGP – 90-120 days; and AESR 14.3 (South Kashmir and Kumaon Himalayas Warm Moist to dry sub-humid Transitional ESR) with deep loamy to clayey brown forest and podzolic soils and LGP – 150-210 days. Abohar area of Punjab is covered by AESR 2.1 (Marusthali) with shallow to deep sandy desert soils and LGP – 60 days.

Crop Rotations

Both Punjab and Haryana are part of Indo-Gangetic plains and rice-wheat system is the main cropping system. Rice-wheat crop rotation covers about 80% area in the states of Haryana and Punjab. Though, this area is not ecologically suitable for rice cultivation, however, the rice was introduced in late sixties to achieve food security of the country. There are several options to replace rice crop in twin states of Haryana and Punjab. However, such optional crops need to be made as remunerative as rice crop through the improvement in productivity and policy support. The alternative crops which have the potential to replace rice in kharif season are maize, moong/urad, pigeonpea (short duration), soybean, fruits, vegetables and agro forestry. In rabi season, wheat is the main crop which may also be replaced with mustard, gram, lentil, barley etc. In kharif season, the sowing of the crops starts in the month May and harvested in the month of October-November whereas in rabi season, the sowing the crops starts from the month of October and harvested in the month of March-April in this region.

Soils and Soil Fertility

Alluvial soil - a fine-grained fertile soil deposited by water flowing over flood plains or in riverbeds, alluvial deposit, alluvial sediment, alluvium, alluvion - clay or silt or gravel carried by rushing streams and deposited where the stream slows down. There is wide range of soil texture from sandy to clay loam in Haryana and loamy sand to silty loam in Punjab state. In Punjab black cotton soils are also found in Bathinda district. Degradation of soil (soil compaction, soil salinity, sodicity, water logging, and pesticide residue), multiple nutrient deficiency, low organic carbon content and decline in the total factor productivity have been observed under different production systems in these States. Urbanization on agricultural land is an emerging problem. Wind erosion, deposition and movement of sand dunes and frequent flooding, excessive permeability of sandy soils, high calcareous nature of soils is some of the other problems encountered by the farmers in Haryana. Some other factors contributing to the rise of these soil problems include impeded drainage, poor water management practices and poor quality of ground water in some parts of these states. The total salt affected area in Haryana in 2016 was recorded to be 3.1 lakh ha whereas in Punjab, the salt affected area was found to be 1.52 lakh ha. The soil pH in these states varied from 6.5 to 7.2. As far as soil fertility in the region is concern, the organic carbon was found to be low (0.3- 0.4), Available Phosphorus and Potassium were observed medium and Nitrogen was low in most of the locations in Haryana. In Punjab, there is variability in the availability of nutrients in the soils. In Fazilka and Firozpur, the organic carbon and NPK was found to be low, medium in Gurdaspur, Pathankot, Moga & Panchkula and high in Sangrur and Bathinda districts.

Adaptation of Organic Farming and Issues

Punjab and Haryana have almost same soils, physiography and climate but average landholding size in Haryana is smaller (1.7 ha) than landholdings in Punjab (2.25 ha). Almost 50% landholdings in Haryana are <5 ha. In Punjab, >96% of cultivated area is irrigated while in Haryana 84% of cultivated area is irrigated. In both the states, declining soil health has emerged as major issue for stagnant productivity. Contaminated and depleted groundwater levels and labor scarcity are other very important issues, which need immediate attention of all the stakeholders. Most of the big farmers give their large landholdings on lease. There comes injudicious use of agrochemicals and fertilizers during the cropping period. Apart, from trainings under skill development huge awareness and motivation campaigns are desired for adopting the measures to improve soil health, groundwater condition and crop residue management.

Cost of Cultivation and Net Profit

In state of Punjab, a total 10 farm labs were established, and Basmati rice was taken during last kharif season. In Haryana, out of total 18 farm labs, 16 were from irrigated area and 2 were from rainfed area. In 15 farm labs, Basmati rice was grown, in one farm lab Pearl millet and in two farm labs from rainfed area, Guar was taken during last kharif. All the farm labs were supplied with Organic fertilizer products of Patanjali. In all the farm labs the productivity was observed high. In Haryana, at least 5 farmer trainers were provided Basmati-370 seed. The yield was high, and quality of produce was also very good. The cost of cultivation for paddy ranged from INR 15,000/- to 22,700/- per acre and net profit ranged from INR 20,350/- to INR 43,600/-. The produce of Basmati-370 grown with organic practices was sold @INR 7000/- per quintal. In two farm labs under Guar, the cost of cultivation was INR 5000/- per acre and net profit was INR 10,500/-. In Punjab, the cost of cultivation for all 10 farm labs under paddy, the cost of cultivation ranged from INR 5,300/- to INR 11,500/- per acre and the net profit ranged from INR 17,600/- to INR 45,000/- based on variety grown.

Recommendations

More extensive program of trainings and motivations will bring more farmers for organic farming. The state government of Haryana has started few good programs to promote organic farming. More awareness among the farmers is observed in Haryana. Cluster development and helping the organic growers for certification and market access will help in adoption of climate smart technologies in order to improve soil health and water use efficiency. Horticulture department is working aggressively in this area. NABARD is also desired to work aggressively. ICT interventions may help the organic growers to access the advisory services. In Punjab a community-based approach for crop residue management will help. The rice crop in kharif season may be replaced with maize, moong/urad, pigeonpea (short duration), soybean, fruits, vegetables and agro forestry and wheat in rabi season with mustard, gram, lentil, barley etc. with the improvement in productivity and support prices.

Rajasthan

The total geographical area of the state of Rajasthan is divided in 4 Agro-Eco-Subregions. AESR 2.1 (Marusthali, Hot Hyper Arid) with 12.7 million ha area, shallow and deep sandy desert soils, Irrigation coverage less than 33 percent and cropping intensity only 124 percent and LGP is less than 60 days. AESR 2.3 (Rajasthan Bagar, North Gujarat Plain and South-Western Punjab Plain) with 11.3 million ha. geographic area, deep loamy desert soils, agriculturally a highly developed area with high crop output and high farmer's annual income; 150% Cropping intensity, almost 64 percent irrigated area, 80% groundwater development and 60-90 days LGP. AESR 4.2 (North Gujarat Plain, including Aravalli range and East Rajasthan Uplands) has 8.3 million ha geographic area with deep loamy grey brown and alluvium derived soils. Almost 23 farm-labs are established in AESR 5.2 (Coastal Kathiawar Peninsula Hot Moist Semi-arid). The AESR 5.2 has 9.63 million ha. geographic area with deep loamy coastal alluvium derived soils, high farm income, >60% irrigation development, >80% groundwater development and 120-150 days LGP.

Crop Rotations

A total 25 PFSP farm labs are established in third zone at Jhalawar and Kota districts. The main crop rotations being followed in the area are Rice – Wheat/ Barley, Soyabean – mustard/ coriander/ garlic/ wheat/ fenugreek, Soyabean – Mustard/ gram/ coriander/ lentil. The Kharif crops are sown from last week of June to last week of July and harvesting is done in October – November. Rabi crops are sown in last week of October to November and are harvested in March – April.

Soils & Soil Fertility

The soil testing using the low-cost soil testing kit 'Dharati ka Doctor' revealed that most of the area is having low to medium available Potash, medium to High Phosphorus and medium to high nitrogen in the soils. The Organic Carbon status was also observed low ranging between 0.4-0.6. The soil pH was neutral i.e. ranging from 6.9 to 7.5. Most of the one-acre farm labs were having Soybean during the kharif-2019 and were supplied free of cost Prom, Poshak, Jaivik Khad, PSB, KMB, Rhizobium and FYM to apply in the fields and Trichoderma and Pseudomonas to control fungal diseases.

Adoption of Organic Farming and issues

The farmers in rainfed area have adopted organic farming but marketing of the produce at premium price is still a challenge. The PFSP teams have given the awareness to the farmers during trainings about the certification under PGS scheme and now many of the farmers are coming forward to get registered under the scheme with the help of PFSP teams. A few of the soybean farmers started growing Quinoa after learning through the state Govt. about high profitability and lesser crop management cost from various sources but market accessibility for organic produce is still a question in front of the growers.

Cost of Cultivation and Net Profit

The mean annual rainfall received in the district is 910 mm, out of which 833 mm is received during monsoon period. Although the trend of rainfall has shown a declining trend during last 38 years (Bhim Singh, 2016), the district received 1613 mm rainfall during the monsoon period in 2019. The excess rainfall during the month of September and October washed away the crop. Since the crop grown on farm labs was damaged almost 100%, the state Government has decided to pay compensation to the farmers. On an average, the cost of cultivation was INR 7200/- per acre excluding the input bio-fertilizers provided by PBRI. Thus, the net profitability has been in negative values.

Recommendations

The soils of the region are highly suitable for cotton and moderately suitable for rice. Based on the prediction of monsoon, these two crops can be suggested to the farmers as alternative crops in irrigated areas. Particularly for rice for irrigated areas and cotton for rainfed areas. The climate change models are still uncertain due to unpredictable monsoon pattern. But in areas like Jhalawar which already receives almost 1000 mm rainfall annually, high moisture tolerant crops like rice can be taken as substitute of Soybean.

Telangana

Total 8 farm labs have been established in state of Telangana. Out of 8, 6 farm labs are in AESR 7.2 (North Telangana Plateau Hot, moist semi-arid ESR) with Red and black soils and LGP – 120-150 days. Another couple of farm labs are established in AESR 6.2 (Central Western Maharashtra Plateau, North Karnataka Plateau and North Western Telangana Plateau hot, moist, semi-arid ESR) with shallow and medium loamy to red and clayey black soils (medium land deep clayey black soils as inclusion and LGP – 120-150 days. Both the AESRs are agriculturally moderately developed regions with 138% cropping intensity, 37% irrigation coverage and 50% groundwater development. Crop output (Rs./ha) and farmer income is fairly high.

Crop Rotations

Rice is the major food crop and staple food of the state. Other important crops are tobacco, mango, cotton, and sugar cane. Agriculture has been the chief source of income for the state's economy. The Kharif crops are sown in June and the crops are harvested since October to February based on maturity. Rabi crops are sown in the months of November and December, which are harvested in March and April. Out of 8 farm labs in Telangana, 6 were under paddy, 1 under turmeric and 1 under cotton.

Soils & Soil Fertility

The Telangana region soils belong to Vertisols, Alfisols, Inceptisols and Entisols soil orders. Drainage and texture are the major limitations in Vertic Haplustepts, Typic Haplusterts and Chromic Haplusterts for all the crops. Drainage, texture, coarse fragments, soil depth, pH and organic carbon (OC) are the major limitations for crop growth in all the soils. The limitation levels of the land characteristics varied from crop to crop. The suitability classes can be improved if the correctable limitations (Soil fertility characteristics) are altered through soil amelioration measures.

The soil testing in 8 farm labs revealed that Phosphorus and Potash are low to medium, whereas Nitrogen is medium. Organic carbon is ranging between 0.5 to 0.7. The pH in all the farm labs ranged from 6.5 to 7.5. Out of 8 one-acre farm labs six were having Paddy during the kharif-2019. All the farm labs were supplied free of cost Prom, Poshak, Jaivik Khad, PSB, KMB, Rhizobium and FYM to apply in the fields and Trichoderma and Pseudomonas to control fungal diseases.

Adaptation of Organic Farming and Issues

Farmers have started growing crops with organic methods. But still they need proper extension and training on usage of bio-fertilizers and bio-pesticides in the fields. They need to apply bio-fertilizers based on soil testing report. For indigenous or high yielding varieties, the seed accessibility is an important issue. Under PFSP, the farmer trainers have been motivated to make good networks and search reliable seed companies, from whom they and the farmers who have been trained by them under RPL may get good quality seed of crop varieties in advance before sowing. Average land holding is smaller size (1.12 ha) in the state.

Cost of Cultivation and Net Profit

In farm labs under Paddy, the average cost of cultivation was 32,133/- per acre and the net profit was INR 12,466/-. In farm labs under Turmeric, the cost of cultivation was INR 62,000/- and the net profit was INR 61,200/-. In farm labs under Cotton, the cost of cultivation was INR 24,000/- and the net profit was INR 54,000/-.

Recommendations

Both cotton and turmeric are high profit fetching crops. Some areas are less suitable for cotton but are suitable for turmeric and vice versa. The initial support to organic farmers could be more helpful due to income used to be less in organic farming when compared to conventional farming. Establishment of marketing facilities for certified organic produce may build confidence among the consumers to buy products through organized registered co-operative groups. Some basic financial support to the small and marginal farmers to get organic certification could enhance the interest on organic farming.

West Bengal

The state of West Bengal is covered by 2 AESRs viz., AESR 12.3 (Chhota Nagpur Plateau and Garjat hills hot, dry sub-humid ESR) with deep loamy to clayey red and lateritic soils and LGP – 150-180 days and is agriculturally less developed region; AESR 15.1 (Bengal Basin and North Bihar plain, hot moist sub-humid ESR with LGP – 210-240 days and deep imperfectly to poorly drained loamy (at places clayey) soils. AESR 15.1 is agriculturally a highly developed region, 80% groundwater development and 64% irrigation development, >180% cropping intensity, high farmer income and crop output. Out of total 19 farm labs in the state, only 4 could work which are in AESR 15.1.

Crop Rotations

Being a part of Indo-Gangetic plains, Rice-Wheat, rice-rice and rice-potato, rice-mustard, rice-gram, rice-jute, rice-fallow systems are predominant in the state. Pulses, oilseeds and vegetables (onion) are grown in some area.

Soils & Soil Fertility

The soils in the area of farm labs are mainly alluvial soils Entisols (Fluvaquents), Inceptisols (Eutropepts) and Alfisols (Endoaqualfs) which are imperfectly to poorly drained and remain moist most of the time in the year. Illuviation of clay is a feature and sesque oxides accumulation in the lower horizon has been observed. Soil testing revealed a medium status of available Nitrogen and Potassium and low levels of Phosphorus in all the farm labs with pH ranging from 6.2 to 6.8. Soil Organic Carbon was observed 0.5-0.6 in the soils. Paddy was taken in farm labs by the farmer trainers.

Adaptation of Organic Farming and Issues

Although, the recent alluvial plains of IGP are suitable for rice and climate is also suiting, the continuous cultivation of rice-wheat has exhausted the ecosystem of soils. The organic carbon has reached to its lowest level. Injudicious use of pesticides and chemical fertilizers has contaminated the groundwater and poor drainage in the area further deteriorated the soil ecosystem. Organic farming is being adopted but not very enthusiastically due to political reasons. Good quality seed and market accessibility for selling the organic produce are also major challenges.

Cost of Cultivation and Net Profit

In all 4 farm labs, rice was taken during last kharif season. Almost, all the labs fetched good profitability to the growers. The cost of cultivation in two 1 acre paddy fields ranged from INR 10,500/- to 5000/- and net profit ranged from INR 15,300/- and 20,000/-. However, in other two farm labs the cost of cultivation was INR 5000/- and INR 6000/-, while the profit was only INR 3,200/- and INR 3,000/-. Excess rains damaged the crop.

Recommendations

Less water requiring crops like wheat may give higher returns than summer rice. Resource conserving technologies like less tillage, zero tillage, bed planting of wheat could be more effective. The organic growers who are attending yoga centres could sell the produce through networking. This practice may help the farmers to access the direct selling ways to fetch more profit. The area is on the shores of Bay of Bengal and is prone to cyclones and other climate challenges. Contingency plans could be developed for the growers who are on high risk of losing crops due to calamities.

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Recommendations

1. Organic Farming is one of the Climate Smart Technologies, which should be adopted well by the farmers in order to mitigate climate change impacts, check the soil ecosystem degradation, improving soil organic carbon, water use efficiency and food quality.

2. As has been quoted by several workers recently, any CSA technology should be prioritized based on vulnerability indicators and biophysical factors. Organic Farming should also be promoted considering site-specific management. Agriculturally less developed areas should be considered first. The vulnerable areas like rainfed to bring equity to the farmers' income and then in medium developed areas.

3. Since agriculture is a state subject, a major role has to be played by state agriculture and rural development departments with full heart. Till now, half hearted approach has been made. Panchayat level interventions for seed production, seed banks and storage facilities can be developed. Those panchayats can be declared GMO free. The seed production and supply should be ensured Agro-climatic Zone or Agro-eco-subregion wise.

4. There is a variability in local climate, topography, soil type, practices and ecology. The implementation/promotion of Organic Farming should be done based on Agro-eco-subregions. Very recently, the Agriculture development index revealed that out of 60 agro-eco-subregions, 15 have exhibited low agricultural development (Srivastava et al., 2019) and Naveen P. SIngh, et al., (2019) also suggested in their policy paper that there is a dire need to formulate region-specific interventions and adaptation strategies to deal with climate change and evolve farmers-centric climate adaptation and mitigation policy.

5. Availability of farm yard manure and green manure is a major problem for the farmers adopting organic farming. The mechanization has further reduced the availability but the mechanization is also inevitable and necessary to address the issue of labor scarcity. Thus the alternative resource conserving technologies like Direct seeding, zero till and seed bed planting; crop rotations, tree crops, cover crops, leguminous crops and green manure; and in situ crop residue management has proven helpful in compensating the macro and micro nutrients. Effective extension with motivation can change the mindset of the farmers to apply these solutions.

6. Ensure the availability of seeds, bio-fertilizers, manures and plant protection materials at the farm with the help of Agriculture departments, agriculture universities through farmer fairs and develop local linkages for the low-cost input materials to the farmers and ensure markets for good quality input materials. Seed banks can be developed for traditional seeds at village level.

7. This has been observed that with the erratic pattern of monsoon and changing mean minimum temperature, the yields are likely to reduce for some crops, Agro-eco-subregion wise Crop suitability geospatial database can be prepared, and alternative crops/stress tolerant varieties could be promoted in the regions. High yielding alternate crops/varieties can compensate for the likely yield losses in organic farming. Although, it has been studied that in India, we already have lower yields than potential.

Therefore, for the western countries, the truth of getting very high yield through conventional farming otherwise and a reduction through organic farming, is a myth for Indian marginal farmers adopting organic farming.

8. The efforts by NSDC, Govt. of India are towards enhancing the skill level among the farmers, a step ahead to motivate those skilled farmers by the state departments of agriculture will be able to achieve desired results e.g. Haryana Govt. has recently declared that .

9. Accelerate the process of PGS scheme through appointing officials at block level and running a campaign. Formation of small groups of organic farmers, Self Help Groups in villages and crop residue and waste disposal through community participation is very efficient management.

10. Strengthen Soil conservation measures primarily in vulnerable and less developed Agro-eco-subregions. Patanjali Bio Research Institute has distributed portable low cost and efficient soil testing kits to the trainer farmers. After every crop season, the soil testing is a must to continuously monitor the nutrient status and soil health. Similar affordable soil testing kits can be made available at a group level and the data should be collected by the farmer leader.

11. Ensure Water conservation measures primarily in vulnerable and less developed Agro-eco-subregions. Water harvesting structures developed in a village of Rajasthan has brought miraculous results in farming and socio-economic conditions. The regions having small aquifers exhaust early and get recharged with rain quickly. Earlier, in villages, there were ponds and natural lakes in low lying pockets, which served the water requirement of habitations. In a similar way, small water harvesting structures should be developed, which may supply water to the fields in case of adverse conditions.

12. Promote Beekeeping, piggeries, aquaculture, poultry and dairying as part of mixed farming system. FAO suggests integrated farming systems to mitigate climate change impacts and ecological sustainability. Through self help groups or local clustering approach, integrated farming systems are an effective approach for small and marginal landholders. Institutional credit through agencies like NABARD can be helpful to them. Also, there should be effective implementation of Crop and livestock insurance provision through schemes like 'Pradhanmantri Fasal Bima Yojna'.

13. Organize organic fairs, workshops, seminars and exchange programs for consumers, teachers, farmers, semi-government officials in the cluster areas. The trainings and some motivational upgradations should continue in the clusters. And ensure strict enforcement of Food Adulteration Act, 1954 at district/Panchayat level and enable Agriculture officers, veterinary doctors and similar professionals as food inspectors in the regions.

14. Facilitation of Farmer Producer Companies (FPC) and Farmer Produce Organizations (FPOs) and storage of organic produce by establishing separate and decentralized storage facilities to ensure organic integrity and help the farmers in certification process. Also provide separate local transportation facilities for organic produce to nearby domestic and urban markets.

15. Develop separate market facilities for certified organic produce through the existing channels and also develop new avenues such as schools, hostels, hotels, hospitals, ayurveda centers, and connecting the

FPCs in various geographies to each other, so that the marketing of produce and procurement of inputs (seeds, manures, implements) can be done through networking.

16. There should be provision of financial incentive to the organic farmers as a motivation and also insurance and pension scheme for small and marginal Organic Farmers can be introduced separately.

17. Stringent measures to phase out the highly toxic chemical pesticides under category 1a and 1b should be taken with immediate effect. The ecologically sensitive zones should be declared as pesticide and fertilizer free zones, and these zones should be maintained with rich biodiversity.

18. Sale of chemical pesticides should be regulated through seeking stringent measures and enforcing a prescription- based system, ensuring that pesticides are sold only on a case to case basis after obtaining a prescription from the Agriculture Officer. There should be punishment provision for the officials neglecting the legislature. Periodical tests of food samples, milk and water should be done at district / Panchayat level to monitor the residual quantum of chemical pesticides.

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