AGRICULTURE IN THE CURRENT CONTEXT – OPPORTUNITIES AND CHALLENGES

It is a privilege to be invited for this lecture in memory of Dr. Dayanatha Jha. I am grateful to the National Institute of Agricultural Economics and Policy Research, particularly to Dr. Suresh Pal, Director, for this opportunity. Dr. Jha's contributions to make the Institute a Center of Excellence on research in agricultural policy are well known.

Today, I would like to share our views on **'Agriculture in the current context –opportunities and challenges'.**

Focus areas for deliberation today are:
(i) Sustainability of Indian Agriculture
(ii) Climate Change risk in Agriculture
(iii) Increasing Farmers' income

I. Sustainable Agriculture

In a rapidly changing world, the agriculture sector is witnessing a metamorphosis of unprecedented dimension. In such a quickly changing world, can agriculture be sustainable? This apparent 'paradox' has sparked a million debates and innovative thinking and has provided the much needed direction and a sense of urgency for an agriculture system which needs to be inherently and fundamentally sustainable for survival of *Homo sapiens* as a species.

Defining Sustainable Agriculture

The word sustain comes from the Latin '*sustinere*' (sus-, from below and tenere- to hold), to keep in existence or maintain and implies long-term support or permanence. As it pertains to agriculture, sustainable describes farming systems that are "capable of maintaining their productivity and usefulness to the society indefinitely. Such systems must be resource-conserving, socially supportive, commercially competitive, and environmentally sound."[1]

Some terms defy definition. "Sustainable agriculture" is one of them. Let me quote a definition of "Sustainable agriculture" mentioned in the "Farm Bill"[2] introduced in the US as early as in 1990. Under that law, "**the term**

[1] John Ikerd, as quoted by Richard Duesterhaus in "Sustainability's Promise," Journal of Soil and Water Conservation (Jan.-Feb. 1990) 45(1): p.4.
[2] [Food, Agriculture, Conservation, and Trade Act of 1990 (FACTA), Public Law 101-624, Title XVI, Subtitle A, Section 1603 (Government Printing Office, Washington, DC, 1990).

sustainable agriculture" means an integrated system of plant and animal production practices having a site-specific application that will, over the long term:

- satisfy human food and fiber needs;
- enhance environmental quality and the natural resource base upon which the agricultural economy depends;
- make the most efficient use of non-renewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls;
- sustain the economic viability of farm operations; and
- enhance the quality of life for farmers and society as a whole."

Paramparagat Kheti in India – the agricultural heritage

India has a long history and tradition of harmonious co-existence between man and nature. We represent a culture that calls our planet 'Mother Earth'. Since the Vedic age, we have been practicing 'paramparagat kheti', a form of agricultural practice which is organic, non-exploitative and totally in harmony with the nature. Environmental sustainability, which involves both intra-generational and inter-generational equity, has been the approach of Indian agriculture for a very long period of time. Traditionally, man, animals, trees (including grass lands) and agricultural fields were inseparable and harmonious components of a single system[3]. The villager looked after the trees on his fields and also contributed to the maintenance of the community grazing land. He looked after the animals owned by him, sometimes with the assistance of a grazing hand and cultivated the fields owned by him, with or without hired labour or share-croppers.

The trees provided fodder for the cattle. They also provided fuel for the villagers. The leaves that fell were put to uses beneficial to the agricultural fields. Meanwhile, their soil and water conservation properties were beneficial for the villagers and contributed to maintaining the fertility of agricultural fields, as well as providing shade during the scorching summer. In addition, certain trees provided edible fruits, medicines, gums, toothpaste and a host of other commodities of everyday use. In some villages trees were used for lac cultivation, and for raising silkworms and bees. Owing to their water conservation properties trees were also

[3] http://satavic.org/traditional-agriculture-in-india-high-yields-and-no-waste/

responsible in several villages for ensuring an adequate supply of drinking water.

Cattle provided milk and milk products and contributed to the nutritional content of the villagers' diet. Cattle dung provided organic fertilizers for the fields, while the poultry provided eggs and meat. The skins of dead cattle were used for making footwear and other leather products—all such activities being carried out in the village. Not least, bullocks ploughed the fields.

The fields produced food grains, pulses, oilseeds and vegetables for the villagers. The residues of those crops, of no direct use to man, were fed to the cattle. Poultry birds scavenged the wasted, scattered grain. The agriculture heritage of India was therefore in total harmony with nature and therefore self-sustaining.

Need for a new approach to Agriculture in India

However, with the increase in population, green revolution, a resource intensive cultivation technology was introduced in early 1960's which resulted in exponential increase in production and productivity in certain major crops like wheat & rice in India, especially in the green revolution areas of our country. However, this 'seed-water-fertilizer' technology has been criticized by many economists as a technocratic solution with major sustainability and equity concerns.

Further, of late, climate change has emerged as the biggest risk multiplier in the agriculture sector of India. Few countries in the world are as vulnerable to the effects of climate change as India is with its vast population that is dependent on the growth of its agrarian economy. The vulnerability to climate change is accentuated by the fact that India's agriculture sector, with a mere 2.4 per cent share of the world's land and a 4.0 per cent share of the world's freshwater resources, has to cater to 17.5 per cent of the world's population[4].

Thus, a totally new approach based on the following twin sustainability requirements is a sine-qua-non for the agriculture and allied sector. Agriculture in India has to be ecologically sustainable in the use of natural

[4] Statistics from State of Indian Agriculture, 2015-16, Department of Agriculture, Cooperation and Farmers' Welfare ,MOA

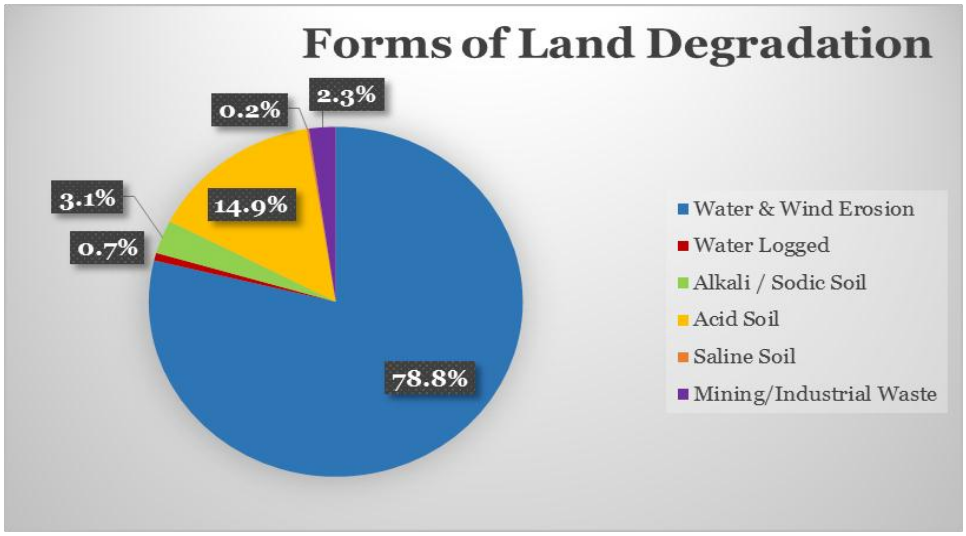
resources: Land, Water, and Forest & also socio-economically sustainable to farmers in terms of prosperity, welfare and social security.

Sustainability Issues in Indian Agriculture

(I) Sustainability Issues

Land Degradation

Nature takes about 300 years to form 1 cm of top soil. It is a matter of concern that 5.3 billion tons of soil gets degraded annually in India. Soil loss is about 16.4 tons per ha, annually. ICAR reported that out of the total geographical area of 328.73 million hectares, about 120.40 million hectares (37 per cent) were affected by various kinds of land degradation[5].The different forms of land degradation in India is furnished in the pie-diagram given below:



The quality of soil has also deteriorated over time due to a combination of factors, such as injudicious use of chemical fertilizers, accumulation of heavy metals and metalloids through various forms of emissions.

Water Scarcity

Regional Imbalance

There is a huge temporal and spatial variation in rainfall and water availability in the country. Most of the water is available during the monsoon, and in a few spells of intense rainfall, resulting in floods in major rivers. Estimates show that whereas the lower rainfall zone (less than 750

[5] Degraded and Wastelands of India: Status and Spatial Distribution, 2010, ICAR

mm annual rainfall) accounts for 33 per cent of the net sown area, the high rainfall zone (1125 to 2000 mm) covers 24 per cent of the net sown area and the very high rainfall zone (more than 2000 mm) accounts for the remaining 8 per cent of the net sown area.

Irrigation Potential

Out of the total geographical area of 329 million hectares (mha) of the country, the total cropped area is about 194 mha, out of which net sown area is only about 140 mha. Only about 66 mha, i.e., 47.6 per cent of the net sown area, is reported as irrigated. There is a need to bring more cropped area under assured irrigation to increase agriculture productivity and production. The ultimate irrigation potential of the country is estimated at about 140 mha, with about 76 mha from surface water sources and about 64 million hectares from groundwater sources. There is an urgent need to invest large amount of resources to augment irrigation to its potential level.

Poor Irrigation Efficiency

The average annual rainfall is 1170 mm (1.17m). Taking 70 per cent of the rainfall as effective for crop consumptive use, the gross water use is about 1.45 m (4.8 feet) per ha of the gross irrigated area. This is very high compared to water use in irrigation systems in developed countries, such as the USA, where water allocation is about 90 cm. This overuse in the country reflects low irrigation efficiency, of about 25 per cent to 35 per cent in most irrigation systems, with efficiency of 40 per cent to 45 per cent in a few exceptional cases[6]. The method of irrigation followed in the country is flood irrigation, which results in a lot of water loss.

Wasteful use of ground water

Groundwater accounts for about 60% of the irrigated area. Heavy subsidies in electricity consumed for agriculture have tended to encourage wasteful use of energy and water. This has also encouraged farmers to overdraw water from deep aquifers, causing substantial depletion of the water table and deterioration of water quality in many cases.

Competing demand

The demand for water for various purposes is increasing due to population growth, urbanization and industrialization. Presently, the agriculture sector is using about 83 per cent of available water resources, but demand from other sectors may reduce availability for agricultural use to 68 per cent by 2050.

[6] State of Indian Agriculture, 2015-16, Department of Agriculture, Cooperation and Farmers' Welfare ,MOA

Excessive & distortive use of Chemical Fertilizers

Chemical fertilizer use has seen rapid expansion and intensification in India. The average consumption of fertilizers in India rose from 105.5 kg per ha in 2005-06 to 128.34 kg per ha in 2012-13.A common belief is that the ideal balance among N, P and K in India is 4: 2: 1. In 2012-13, the proportions stood at 8.2:3.2:1.

In this context, it is noteworthy that a recent National Institute of Agricultural Economics and Policy Research (NIAP) study[7] reports that one third of the major states apply excess N and two thirds apply it at below optimum level. While six states, namely, Andhra Pradesh, Assam, Punjab, Bihar, Haryana, and Jharkhand, use proportionately more N than would be warranted by the optimal mix, 12 states use it in suboptimal proportion. The study finds similar regional imbalances in the use of P and K.

Excessive Use of Pesticides

Although in per hectare terms pesticide use in India is much lower than in other countries, especially developed ones, pesticide residues in produce in India have been found to be high. There are at least five reasons for this phenomenon[8]. First, while pesticides are overwhelmingly used to control weeds in the developed countries, they are used to control insects that attack grains, fruits and vegetables in India. Second, chemicals used in India are more dangerous than those used in developed countries. In India, organochloride formulations, which are more dangerous, continue to be used whereas the developed countries have shifted to safer organophosphates and pyrethroids. Third, after being applied, pesticides remain in soil, water or plant for some time before they break down. Farmers often lack knowledge of waiting period of various pesticides. Fourth, The Central Insecticide Board and Registration Committee (CIBRC) regulates pesticide use in India. Farmers often remain unaware of pesticide recommendations of the CIBRC. Farmers are also unaware of the bio-pesticides that currently constitute 4.2% of the total pesticide market in India. Finally, high pesticide residues in Indian food products also result from inadequate access to latest technologies.

7.Raising Agricultural Productivity and Making Farming Remunerative for Farmers : An Occasional Paper NITI Aayog, Government of India, 16 December 2015

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5. **Strategies for Sustainable Development:**

Some of the strategies for sustainable development are outlined below:

- Improving basic **rural infrastructure** including irrigation infrastructure
- **Soil & Water Conservation**: Watershed development & management practices
- **Water storage, augmentation and improving irrigation efficiencies**: Rain water harvesting, construction of check dams, ponds, Khet talabadi, irrigation efficient technology like drip and sprinkler
- **Harnessing Solar energy**: both for new pump-sets & substitution of old and inefficient diesel pump sets
- **Afforestation**: Over the last 30 years, forests nearly two-thirds the size of Haryana, have been lost to encroachments (15,000 sq km) and 23,716 industrial projects (14,000 sq km).Forest is an important part of the agricultural eco-system. Large scale afforestation, encompassing commercial forestry, farm forestry, social forestry, captive plantation as also adoption of community based forest management practices like Joint Forest Management is the need of the hour.
- **Integrated Farming System**[9]**:** Integrated Production/Farming is a farming system that produces high quality food and other products by using natural resources and regulating mechanisms to replace polluting inputs and to secure sustainable farming. Emphasis is placed on:
  - a holistic systems approach involving the entire farm as the basic unit,
  - the central role of agro-ecosystems,
  - balanced nutrient cycles,
  - the welfare of all species in animal husbandry, and
  - preservation and improvement of soil fertility, of a diversified environment and the observation of ethical and social criteria**.**
- **Natural resource allocation among competing demands:** Current land use pattern for agriculture in many states are not based on principle of comparative advantage. Crop patterns in various regions are inefficient in terms of resource use and unsustainable from natural resource use point of view. This is resulting into serious misallocation of resources, efficiency loss, indiscriminate use of land

[9] IOBC / WPRS Commission "IP-Guidelines and Endorsement" IOBC WPRS Bulletin Vol. 27 (2) 2004

and water resources, and adversely affecting long term production prospects. Further, policy distortions through support in terms of price guarantee, assured marketing and subsidized inputs particularly energy, water and fertilizers are accentuating the problem.

The allocation of natural resources should follow the principle of sustainability and efficiency for right sharing of resources among competing demands. What agriculture commodity to produce & how much to produce & export should be decided based on the twin principles of sustainability and efficiency. Unfortunately, agriculture in India is predominantly focused on raising water-intensive crops like rice and wheat at the expense of dry land crops like pulses.

Further, India, a water scarce country, has been "exporting water" as a result of distorted incentives. Goswami and Nishad (2015) estimated water content embedded in crops at the time of trade. This is different from water used in production, which is much higher. Water "embedded" in crops is the water content of each crop and once the crop is exported, it cannot be recovered. In 2010, India exported about 25 cu km of water embedded in its agricultural exports. This is equivalent to the demand of nearly 13 million people. India was a "net importer" of water until around 1980s. However, with increase in food grain exports, India has now become a net exporter of water – about 1 per cent of total available water every year. The ratio of export to import of such virtual water is about 4 for India and 0.1 for China. Thus, China remains a net importer of water. This is also evident in China's and India's trade patterns. China imports water-intensive soybeans, cotton, meat and cereal grains, while exporting vegetables, fruits and processed food. India on the other hand, exports water-intensive rice, cotton, sugar and soybean[10].

- **Need for appropriate regional planning:** There is a need to develop optimal crop plan at regional levels for better resource use efficiency, sustainability and maximizing farm income based on the study of the existing land use, cropping pattern, and resource efficiency across regions. Only an optimal crop planning, based on comparative advantage principle taking into account both natural resource endowments and agro-climatic zones, would ensure both

[10] Economic Survey 2015-16, Chapter4

sustainability of the agricultural production system and maximization of return.

- **Risk reduction** : Diversification of the cropping pattern, integrated pest management, crop insurance
- **Capacity building, reskilling and new skill-sets for sustainable agriculture**: Farmers need to be made aware and their capacity built on green and sustainable practices like SRI,SSI, protected cultivation techniques, climate smart agriculture, water conservation measures, harnessing solar energy for agricultural purposes, etc.

II. Facing the Climate risk

All of us have observed with concern, consistent warming trends and more frequent and intense extreme weather events across India in the recent decades. The impact of climate change on agriculture has large detrimental effects on availability of food, livelihoods, income of farmers and the overall economy. Small and marginal farmers, pastoralists and fisher folk will be the worst sufferers. Some of the major anticipated impacts are highlighted below:

1. Macro-impacts of Climate Change:[11]

At the macro-level the following adverse effects of climate Change on Indian Agriculture have been predicted.

- Reduction of Agriculture Yields in Medium term (2010- 2039): up to 4.5 -9%.
- Reduction of Agriculture Yield in Long Term (2040 and beyond) : > 25%, if no measure is taken.
- Fall in GDP growth in Medium Term: up to 2% per annum.

2. Climate Risks at three levels[12]

(i) Crop :

- Yield: 15 -17 % decrease in yields of wheat and rice for a 2°C rise in temperature. Wheat, which is generally grown in the winter, is predicted to be affected more than rice.
- Quality: High night time temperature increases respiration rate, decreases membrane thermal stability and negatively affects the

[11] Network Programme on Climate Change(NPCC),ICAR,2009:

[12] National Mission For Sustainable Agriculture :Strategies for Meeting the Challenges of Climate Change, Department of Agriculture and Cooperation, MOA,GOI

yield in rice. In wheat, grain number and weight is reduced due to prolonged high temperatures and drought conditions.

- Climate change would aggravate the adverse impacts of Pests and Insects. Drought decreases plant defense mechanism and creates more favorable environment for pests and insects.

(ii) Soil & Water

- Availability & quality of both surface and ground water will be affected.
- Reduction in ground water recharge will affect irrigation
- Degradation in soil quality and moisture content
- Possibilities of salination of land due to sea water ingress and salt accumulation

(iii) Livestock & Fisheries

- Livestock will be affected due to heat stress, new diseases, poor quality of feed and rising fodder prices
- Heat stress will reduce milk production by 10 -25%
- Warming will affect reproductive rates of livestock
- Changes in aquatic habitat and ecosystem would impact fisheries.

3. Key Risks: The key risks to Indian agriculture due to climate variability include:

- Increased threat of food insecurity and malnutrition
- Increased threat to livelihood of farmers
- Reduced return from farming
- Farmers' distress
- Huge resources for adapting and mitigating the climate risk in the agriculture sector

4. Resource requirement to meet the climate change risks in the Agriculture and allied sector[13]: Preliminary estimates indicate that India would need around USD 206 billion (at 2014-15 prices) between 2015 and 2030 for implementing adaptation actions in agriculture, forestry, fisheries infrastructure, water resources and ecosystems. Apart from this there will be additional investments needed for strengthening resilience and disaster management.

[13] India's INDC to UNCCC.

5. Climate Smart Agriculture: Meeting the climate risk

Climate Smart Agriculture is defined as:

"Agriculture that sustainably increases productivity, resilience (adaptation), reduces and/ or removes GHGs (mitigation) and enhances achievement of national food security and development goals". **- FAO**

5.1 CSA: Interventions

Weather Smart	Aquifer Smart	Carbon Smart
• ICT based weather & agro advisories • Crop Insurance • Climate analogue	•Aquifer recharge •Rain water Harvesting •Community management of water / Water budgeting •On farm water management •Laser leveling	•Conservation agriculture •Agroforestry •Plantation, Horticulture •Land use system •Livestock management

Nitrogen Smart	Energy Smart	Knowledge Smart
•Site-specific nutrient management •Organic farming •Precision fertilizer •Catch cropping / legumes	•Bio - fuels •Fuel efficient Energy Management •Residue Management •Minimum / No tillage •Use of solar/ renewable energies	•Farmer – farmer learning •Farmers' network on adaptation knowledge sharing •Market information & intelligence •Seed & Fodder Banks

III. Increasing Farmers' income

1. Structural Transformation of Agriculture Sector

As all of you are aware, Indian agriculture is going through the process of structural transformation. Over the years, the decline in agriculture's contribution to GDP has been faster than the percentage of population dependent on the agriculture sector. This has generated a trend of pauperization of Indian farmers. Presently, agriculture contributes about 14% of the GDP but more than 50% of the population are still dependent on the agriculture sector for livelihood. This has led to largescale unemployment, under-employment and to what Professor Nurkse calls – 'disguised unemployment'.

2. Declining profitability & income from farming

Further, Farming in India is characterized by small and fragmented holdings and high dependence on monsoon rains. Operating small holdings is often unviable and farming is not a profitable business or enterprise. Farmers earn income from various sources, viz., crop cultivation, horticulture, dairy, poultry, fisheries, other allied activities, non-farm activities, and wage employment. During the last 30 years, the income disparity between farmers and non-farmers has increased. In 1983–84 the average income of a farm household used to be about a third of that of a non-farm household. By the year 2004–05, this statistic had reduced to one-fourth. There was some improvement during the subsequent period, up to 2013–14, due to agriculture growth.

Research based analyses of income estimates for farmers are limited. Some of the prominent studies were by Sen and Bhatia (2004)[14], Dholakia et al (2014)[15] and Chand et al (2015)[16]. As per Chand et al's estimate, the real income grew at the compounded rate of 3.94 per cent per annum during 2004–05 to 2011–12, which is the fastest compared to previous two decades. Based on the trends in farm income from 1983–84 till 2011–12, Chand et al (2015) concluded that:

- The income earned by farmers net of input cost and wage bill has seen low and high growth paths in different periods;

[14] Sen, Abhijit and M.S. Bhatia (2004), Cost of Cultivation and Farm Income, State of the Indian Farmer – A Millennium Study, New Delhi: Academic Foundation

[15] Dholakia, Ravindra H., Manish B. Pandya and Payal M. Pateriya (2014), Urban – Rural Income differential in Major States: Contribution of Structural Factors, W.P. No. 2014-02-07, Indian Institute of Management, Ahmedabad

[16] Chand, Ramesh, Raka Saxena and Simmi Rana (2015), 'Estimates and Analysis of Farm Income in India, 1983-84 to 2011-12', Economic and Political Weekly, Vol L, No 32, May 30.

- The growth in farm income accelerated during the recent period
- Decent growth in farm income requires high growth in output, favorable farm produce prices, and some cultivators moving out of agriculture to non-farm activities

The major source of information on income of farmers based on large sample survey is Situation Assessment Survey (SAS) by NSSO conducted during 2002–03 for the first time and repeated during 2012–13. These surveys indicate that the average total income of farm households increased by 11.75 per cent per annum from Rs 25,320 in 2002–03 to Rs 77,112 in nominal terms. The largest share of farmers' income was from cultivation, which increased from 46 per cent in 2002–03 to 48 per cent in 2012–13. This was followed by wages and salaries, the share of which declined from 39 per cent to 32 per cent during the same period. Contribution of livestock to farmers' income increased from 4 per cent to 12 per cent. The share of income from non-farm sector declined from 11 per cent to 8 per cent.

Real income of farmers, calculated on the basis of GDP deflator, showed a real growth rate of 5.24 per cent during the period 2002–03 to 2012–13. This implies that while farmers' nominal income doubled in 6 years, real income took 14 years to double.

The growth rates in nominal income of farm households across major states of the country varied from 6.71 per cent in West Bengal to 17.48 per cent in Haryana. Nominal income doubling time is 8 to 11 years for states like Assam, Bihar, J&K, Jharkhand, and West Bengal. For all other states doubling time for nominal income is around 6 years or less.

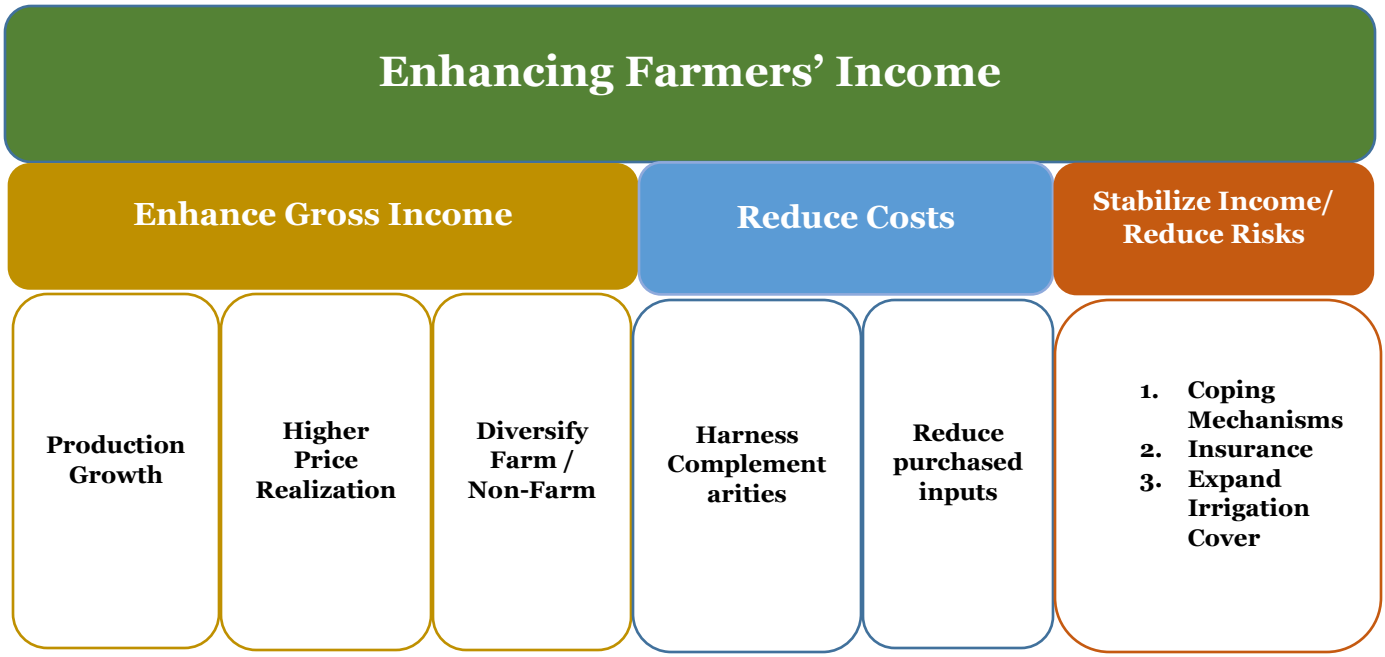
However, the lowest real growth rate recorded was less than one per cent in Assam and the highest was 9.81 per cent for Madhya Pradesh. The doubling time is beyond 10 years for all states barring Andhra Pradesh, Madhya Pradesh, Odisha, and Rajasthan. Further, if the Consumer Price Index for Agricultural Labourers is used, the annual growth rate of real income for farmers falls to 3.5 per cent. With this growth rate farmers' income will double in 20 years.

The Hon'ble Finance Minister in his Union Budget Speech 2016–17, had highlighted the need to think beyond 'food security' of the country to focus on 'income security' of the farmer. He had accordingly announced the target of doubling farmers' income.

3. Strategies for enhancing farmers' income:

The strategy for enhancing farmers' income has to be designed based on the local agro-climatic and socio-economic parameters. However, a highly generalized strategy is diagrammatically represented below:

Some interventions for enhancing farmers' income could be**:**



3.1 Enhancing Production through Yield Increase: This includes:

- adoption of recommended/improved agronomic practices,
- adoption of improved technologies
- farm mechanization
- planning profitable crop mix that can maximize aggregate income,
- reducing crop losses through integrated pest management,
- varietal improvement through conventional breeding or biotechnology (long term)

3.2 Leveraging Water Resources for Enhancing Farm Incomes

- adoption of drip & sprinklers
- Watershed management & conjunctive use of water,
- agronomic practices, such as soil additives and mulching, System of Rice Intensification (SRI),
- rainwater harvesting, farm ponds
- water users associations

3.3 Income Enhancement through Diversification

- Diversification towards high value crops
- Diversification towards livestock, poultry and fisheries and other feasible allied livelihood activities
- Supplementary and complementary non-farm activities, especially for small holders who do not possess adequate land

3.4 Reducing Costs through Low Input Agriculture

Organic farming, low external input, sustainable agriculture, precision farming, etc. may be promoted with a view to reducing cost of cultivation.

3.5 Promotion of Integrated farming system approach

Promotion of Integrated farming system approach involving synergic blending of crops, horticulture, dairy, fisheries, poultry, etc.

3.6 Popularization of innovative Farming Techniques: Popularizing adoption of innovative farming technologies like SRI, SSI, protective cultivation methods like greenhouse, poly-house, etc. for productivity/income enhancement and risk management.

3.7 Agri- enterprise: Agriculture has to be seen as an enterprise; the farmer, an entrepreneur; and the goal, income & profitability enhancement, as opposed to productivity enhancement. The farmer can increase his income through value addition in the form of grading, sorting, processing, packaging, and marketing i.e. functioning as an agri-entrepreneur. Agro-processing and agri-entrepreneurship offers enormous potential for income enhancement to Indian Farmers.

3.8 Producer Organizations: India has over 12.5 crore farmer households, of which over 85% are small and marginal farmers with land holdings of less than 2 hectares. The average size of land holding is 1.16 hectare/ farmer household. Due to this fragmentation and disorganization, farmers face issues of procuring inputs like seeds and fertilizers at reasonable prices. They are also unable to realize good value from their marketable surplus by individually selling their produce. Farmers coming together under the platform of Producer Organizations can aggregate their produce and thus reap the benefit of economics of scale in the entire supply chain in the form of lower input price and higher price realization, better access to market and credit. Organizing farmers into Producer Organizations has the potential to catapult Indian Agriculture from subsistence farming to commercial farming through the vehicle of aggregation.

3.7 Income Enhancement through Professionalization

Providing training and skill transfer to farmers can be very useful in enhancing the income of farmers.

3.8 Risk Management

- taking insurance cover for crops
- providing weather, price, market advisories

- ex-ante adaptation strategies such as investing in wells, mixed farming, sharecropping, stocking grains
- ex-post strategies like replanting, changing input use and thinning the standing crop, etc.
- price stabilization mechanisms such as building bonds with commission agents/traders, entering into contracts, etc.

4. Initiatives by Government of India:

As there are complementarities in the measures and initiatives taken by the GOI in meeting the above mentioned challenges, I have taken the liberty of briefly highlighting some of the major policy interventions initiated by the GOI in a combined fashion.

The Government of India is committed to accord high priority to water conservation and its management. To this effect the **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)** has been formulated with the vision of extending the coverage of irrigation **'Har Khet ko pani'** and improving water use efficiency **'More crop per drop'** in a focused manner with end to end solution on source creation, distribution, management, field application and extension activities. **The Paramparagat Krishi Vikas Yojana (PKVY)** is an initiative to promote organic farming in the country and was launched by the Government in 2015. **The Soil Health Card Scheme** was launched by the Government in February, 2015, with the objective of issuing crop-wise recommendations of nutrients and fertilizers required for the individual farms to help farmers improve productivity through judicious use of inputs. Similarly, **Neem Coated Urea** is being promoted to regulate the use of urea, enhance its availability to the crop and cut on cost.

The **National Mission for Sustainable Agriculture (NMSA)** has been formulated for enhancing agricultural productivity especially in rainfed areas focusing on integrated farming, water use efficiency, soil health management and synergizing resource conservation. The **Rainfed Area Development (RAD)** programme adopts an area based approach for development and conservation of natural resources along with farming systems.

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

For mitigating agricultural risks, **The Pradhan Mantri Fasal Bima Yojana (PMFBY)** was launched by the Union Government in February, 2016. The Scheme aims for supporting sustainable production in the agriculture sector by way of providing compensation to farmers suffering crop loss/damage arising out of unforeseen events, stabilizing the income of farmers to ensure their continuance in farming, encouraging farmers to adopt innovative and modern agricultural practices and ensuring flow of credit to the agriculture sector; attributing to food security, crop diversification and enhancing growth and competitiveness of the agriculture sector besides protecting farmers from production risks. All loanee farmers (including share croppers and tenant farmers) are compulsorily covered under the scheme. The Union Government has set an ambitious target to increase insurance coverage from 23% of the Gross Cropped Area (GCA) to 50% of GCA within the next 2-3 years.

5. Initiatives by NABARD for sustainable development:

5.1 Watershed Development:

NABARD entered into watershed development activities through the KfW assisted pilot project under the Indo German Watershed Development Programme (IGWDP) in the year 1992 in Maharashtra, wherein the participatory approach of watershed development was launched in India for the first time. Subsequently, the initiatives were then extended to other States under the IGWDP. To demonstrate the success of the Participatory Watershed Development interventions carried out by NABARD under the IGWDP programme, the Watershed Development Fund (WDF) was set up in NABARD during 1999-2000 with an initial corpus of ₹ 200 crore by the GoI and NABARD in equal proportions. The fund has been augmented over the years by way of interest differential earned under RIDF and interest accrued on the unutilised portion of the Fund. As on March, 2017, 600 watershed projects are under implementation in various stages in 19 States and 1275 watershed projects have been completed successfully. The cumulative sanction under all watershed programmes stands at Rs.1745.63 crore, out of which an amount of Rs.1507.82 crore has been released so far covering an area of 19.02 lakh Ha.

5.2 Tribal Development

NABARD has been closely associated with the implementation of KfW, Germany sponsored 'Wadi' programmes targeting the poor tribal families in Gujarat and Maharashtra. The model has been found to be very effective in creating sustainable livelihoods for tribal families. In order to support similar deserving tribal families in other parts of the country, NABARD has

created a dedicated fund called "Tribal Development Fund" (TDF) by making a contribution of ₹ 50 crore. The Fund was operationalised from 01st April 2004 and is being augmented from time to time. The Fund is being used as grant/loan to support 'wadi' development and other sustainable micro enterprises undertaken by tribal families. The cumulative sanction under the Tribal Development Fund (TDF) stood at Rs. 2029.84 crore as on 31 March 2017, while disbursement stood at Rs. 1340.31 crore, covering 5.03 lakh families with 673 projects across 27 states and union territories

Adivasi Development Programme

NABARD has also successfully implemented Adivasi Development Programmes in Maharashtra and Gujarat with financial assistance from the German Government. A total of 19000 families have been assisted under the programmes with an amount of ₹ 110 crore.

5.3 **Producer Organisations:** NABARD, with assistance from PRODUCE Fund has promoted over two thousand Farmer Producer Organizations (FPOs) in 28 states across the country. Swornajyoti Producer Company Ltd. (SPCL) was started by tribal women farmers of Koraput district in Odisha in 2014 with an aim to promote livestock based livelihood activities among marginal farmers by increasing market accessibility and improving farmers' share on production. The company sells poultry birds in the brand name 'Adisha Chicken'. Within one year, SPCL has been able to achieve a turnover of ₹ 553 lakhs.

5.4 Technology Transfer:

Promotion of System of Rice Intensification (SRI) & Sustainable Sugarcane Initiative (SSI): In convergence with the National Food Security Mission (NFSM), NABARD had launched the programme for promotion of System of Rice Intensification (SRI) through transfer of technology covering 84000 farmers and 84000 acres over a period of three years. The programme was launched during Kharif 2010.The total financial outlay of programme was ₹ 25.68 crore and was implemented across 13 identified states. By the end of the project period, 1.42 lakh farmers were covered under the programme encompassing a total area of 36935.61 ha.

Under the Sustainable Sugarcane Initiative (SSI) initiative, NABARD has sanctioned projects in Bihar to support farmers to adopt the SSI cultivation method and improve their production and productivity.

5.3 Climate Change Initiatives of NABARD

NABARD has always taken into consideration social and environmental concerns to achieve the desired development results. NABARD, apart from channelizing and accelerating agriculture credit and its access for rural masses, has taken various policy and developmental initiatives to achieve the environmental sustainability. NABARD in recent past has taken up important steps for accessing national and international funding mechanism to fulfil the need of climate finance.

NABARD has been accredited as National Implementation Entity (NIE) for Adaptation Fund (AF) and Green Climate Fund (GCF) mechanisms under UNFCCC. Moreover, NABARD is acting as NIE under National Adaptation Fund for Climate Change (NAFCC).

Adaptation Fund (AF) of UNFCCC

NABARD has been accredited as National Implementing Entity (NIE) for Adaptation Fund created under United Nations Framework Convention on Climate Change (UNFCCC) for India. Adaptation Fund Board (AFB) has sanctioned 06 projects submitted by NABARD with an outlay of US$ 9.8 million. These projects would benefit 77,225 vulnerable population spread over in six States. The projects so far sanctioned by AFB represent varied agro-climatic regions and livelihood sectors viz., mangrove fish farming in Andhra Pradesh, climate smart agriculture in dryland areas of West Bengal, climate resilient inland fisheries in Madhya Pradesh, climate proofing of watersheds in Tamil Nadu and Rajasthan, climate resilient agriculture for Himalayan region in Uttarakhand as well as reducing climate change linked stress on forest biodiversity in Kanha Pench Corridor of Madhya Pradesh. These projects are designed to generate key learnings for development of adaptation projects which can be mainstreamed under existing programmes and policies.

National Adaptation Fund for Climate Change (NAFCC) - Government of India has also set up National Adaptation Fund on Climate Change (NAFCC) and NABARD is also NIE for that fund. Total 21 Projects in 20 States (including one UT) with an outlay of INR 442.88 crore have been sanctioned so far. These 21 projects cover 57 districts of 21 states and 12,68,506 beneficiaries. These projects are expected to generate key learnings in terms of addressing adaptation challenges being faced by different State and UTs. Further, the experience of implementation of these projects would be an important learning for integration of climate change adaptation in the development planning of existing programmes at State Level. Once these measures are taken up on a large enough scale over

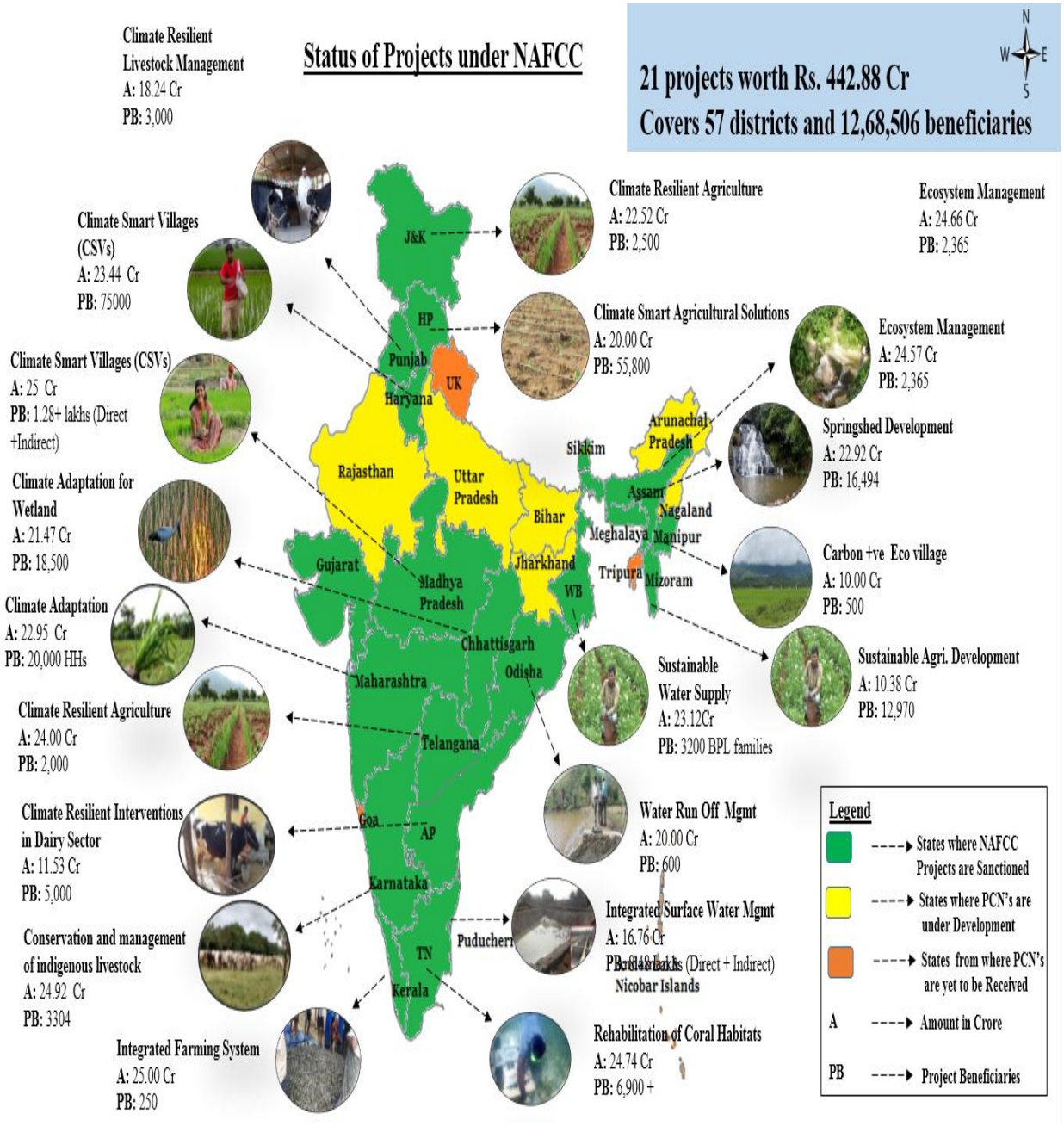
extensive regions, a meaningful impact in a time bound manner may be created.

Green Climate Fund (GCF)

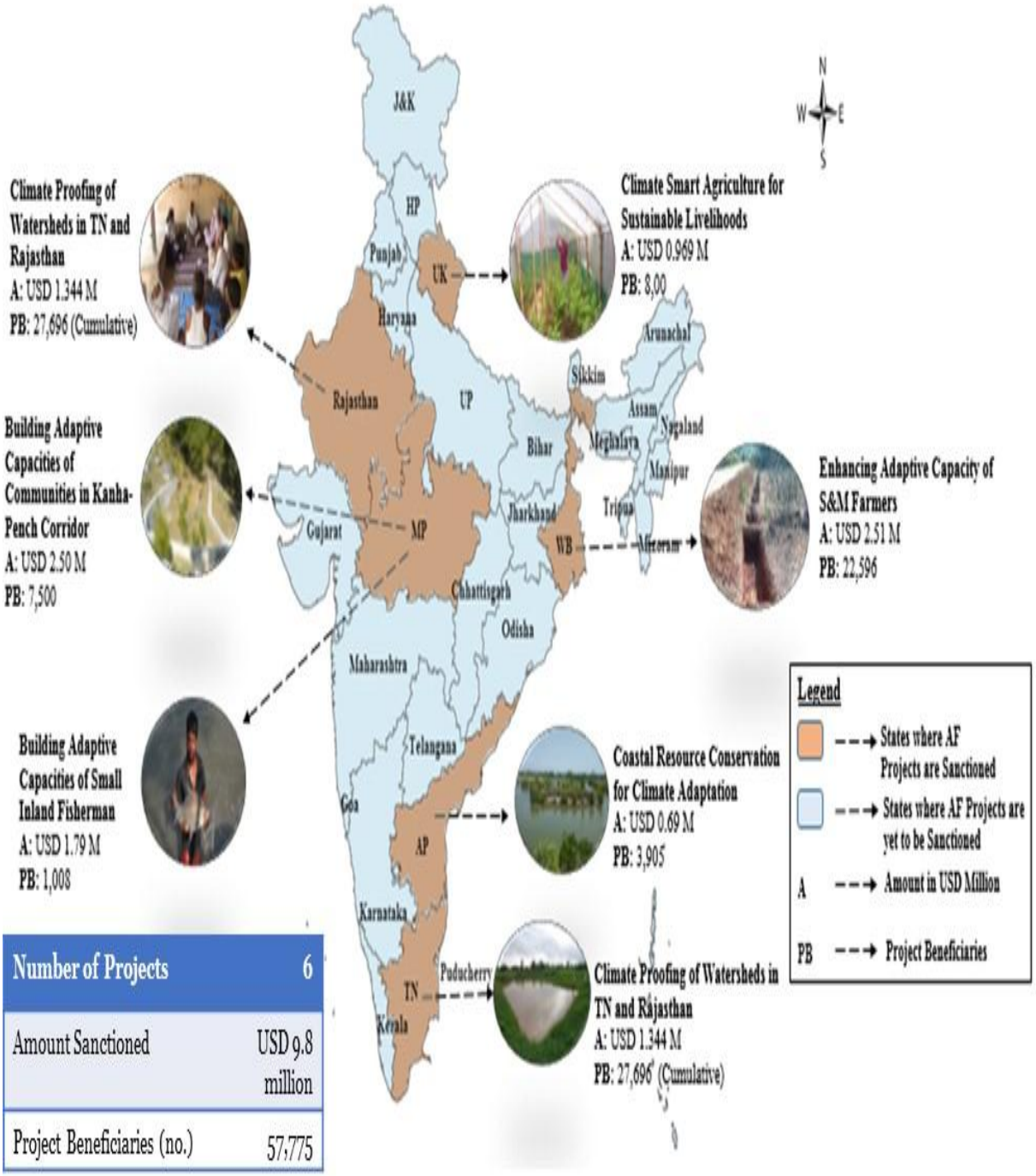
NABARD has also been accredited as Direct Access Entity (DAE) for accessing resources under Green Climate Fund (GCF). The Green Climate Fund has been designated as an operating entity of the financial mechanism of the UNFCCC and aims to support developing countries to limit or reduce their greenhouse gas emissions and to adapt to the impacts of climate change. NABARD aims to use resources under GCF for creating paradigm shift towards low carbon pathways and climate resilient development.

Recently, Green Climate Fund Board in its 16 meeting held during 04 to 06 April 2017 at Songdo, South Korea has sanctioned first ever proposal of India submitted by NABARD. The project "Ground water recharge and Solar Micro Irrigation to ensure food security and enhance resilience in vulnerable tribal areas of Odisha" has a total outlay of USD 166.297 million with GCF support of USD 34.357 million, and balance funds would be supported by Government of Odisha and World Bank. Further, 04 project concept notes with an outlay of USD 450 million have been approved by Empowered Committee constituted for GCF by MoEF&CC, Government of India, for development of DPR and submission to GCF.

Status of Projects Sanctioned under NAFCC (As on 30.04.2017)



Status of Projects Sanctioned under Adaptation Fund (As on 30.04.2017)



Number of Projects	6
Amount Sanctioned	USD 9.8 million
Project Beneficiaries (no.)	57,775

5.4 Umbrella Programme for Natural Resource Management (UPNRM)

The Umbrella Programme for Natural Resource Management is a unique product aimed at promoting efficient Natural Resource Management based business models with a strong capacity building support system. The projects implemented under this programme are pro-poor, environmentally sustainable, have community participation, practice good governance, and are integrated & need-based.

As on March, 2017, 323 projects amounting to ₹ 589 crore have been sanctioned under this programme across 34 sectors in 21 States and 1 Union Territory.

6. Concluding Remarks

To sum up the lecture, Indian agriculture is undergoing rapid metaphasis and in the process is exposed to many endogenous and exogenous challenges. I have talked about only three of the challenges. But I am sure, all stakeholders would combine their resources, technical and financial and managerial to support the farmers to meet the challenges and come out with flying colours.