



THEMATIC PAPER

ROADMAP FOR RESILIENT AGRICULTURE IN INDIA



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FOREWORD

Indian agriculture, like India's landscape, is vulnerable to multiple disasters of natural and anthropogenic nature, and is also aggravated by the impact of climate change. Unlike anytime in the past, challenges to agriculture sector in India have to be understood concurrently in many dimensions. The increased frequency and severity of climate related hazards and risks induced by climate change are adding a new dimension to the existing disaster risk profile of India. Though, there are visible improvement brought by adoption of management practices through on-farm and off-farm operations in this sector, there is also growing risk of disaster related damages and losses to the agriculture systems.

National Institute of Disaster Management (NIDM) is developing a National Agriculture Disaster Management Plan (NADMP) for the Ministry of Agriculture and Farmers Welfare with the aim to strengthen resilience of farming community to deal with disasters and weather uncertainties. The document will also provide guidance to the attached, affiliated and subordinate offices as well as other agencies within the Agriculture Department to manage the risks of disasters before, during and after a disaster. These include assessing the sectoral and departmental risks of disasters, mitigating the existing risks of disasters, preventing creation of new risks of disasters, presenting the status of its preparedness to perform its role and responsibilities as defined in the State DM Policy and State DM Plan, measures proposed for strengthening capacity-building and preparedness etc.

I am happy to learn that the team has come up with this paper describing the roadmap towards building resilient agriculture in India. I believe this paper will help all the professionals and non professionals working in the agriculture sector in understanding the challenges being faced by Indian agriculture in relation to natural disasters.

Manoj Kumar Bindal

Abstract

Majority of Indians are dependent on agriculture directly or indirectly for their livelihood. The share consists of landowners, tenant farmers who cultivate a piece of land, agricultural labourers who are employed on these farms and people doing business of agricultural products. Indian agriculture, like India's landscape is vulnerable to multiple natural and anthropogenic disasters, and is also aggravated by the impact of climate change that results in mammoth economic losses. One of the key drivers behind such increasing economic losses is a lack of appropriate disaster management planning, including risk reduction strategy based on knowledge about hazard impacts and access to risk information. This paper describes different challenges the Indian agriculture is facing like droughts, floods, pest attacks, etc. The different schemes and policies which are already in practice for improving the productivity and to overcome natural disasters are also discussed. This paper also describes the need for a national agriculture disaster management plan for increasing the resilience and sustainability of Indian agriculture as mandated under Disaster Management Act, 2005 and National Disaster Management Policy, 2009.

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Introduction: Indian Agriculture

Since ages, agriculture has been playing a vital role in developing Indian economy as it is the backbone for Indian economy. More than 70% of our rural people depend on agriculture for their livelihood and around 60% of the land is occupied by agriculture activities (FAO, 2019). 18% of India's gross domestic product (GDP) and 50% of country's workforce is accounted by agriculture. Majority of Indians are dependent on agriculture directly or indirectly for their livelihood. The share consists of landowners, tenant farmers who cultivate a piece of land, agricultural labourers who are employed on these farms, and people doing business of agricultural products. According to FAO (2019), India is the largest producer, consumer and importer of pulses in the world (Figure 1).

Next to China, India is the second largest fruit producer in the world. The production of horticulture crops was estimated at record million tons in 2017-18 (Horticulture at a glance, 2018). India is also among the top producers of rice, wheat, pulses, cotton, sugarcane, tea, tobacco leaves, spices, spice products, etc. The major *kharif* crops grown in India are rice, jowar, bajra, maize, cotton, groundnut, jute, sugarcane, turmeric, pulses, etc. The major *rabi* crops are wheat, oat, gram, pea, barley, potato, tomato, onion, oil seeds and the crops cultivated in *zaid* are cucumber, bitter gourd, pumpkin, watermelon, muskmelon, moong dal, etc. The driving forces that make these crops grow efficiently in India are the unique weather and soil conditions. Figure 2 shows agricultural production (million tonnes) of wheat, rice, pulses and oilseeds over the past years. Indian agriculture also addresses food security for the nation. The National Food Security Act in India was enacted in 2013 with the aim to provide food and nutritional security to people by ensuring access to adequate amount of quality food at affordable prices (Despande, 2017).

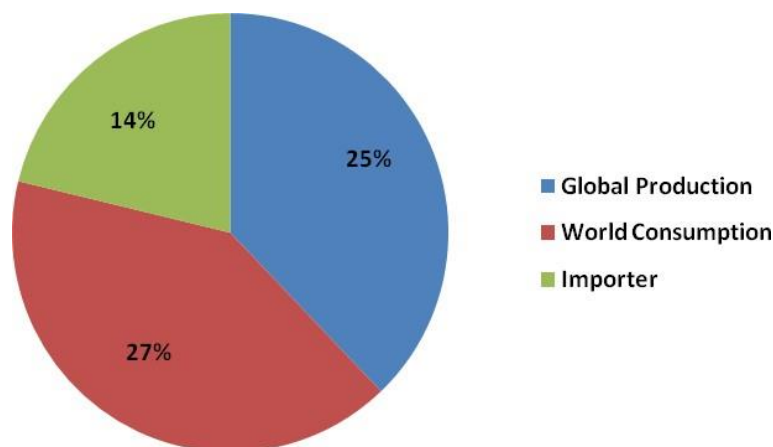
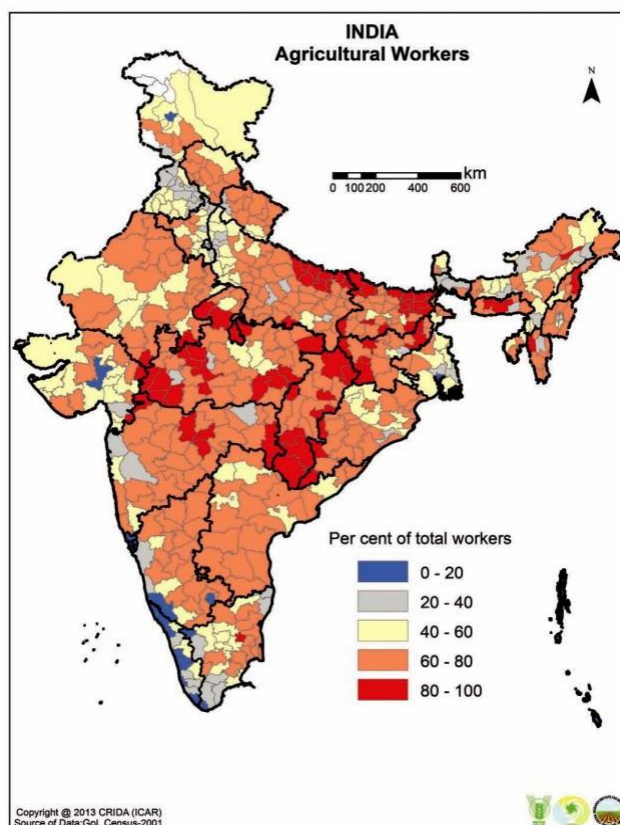


Figure 1. Indian Agriculture's share in the world (FAO, 2019)

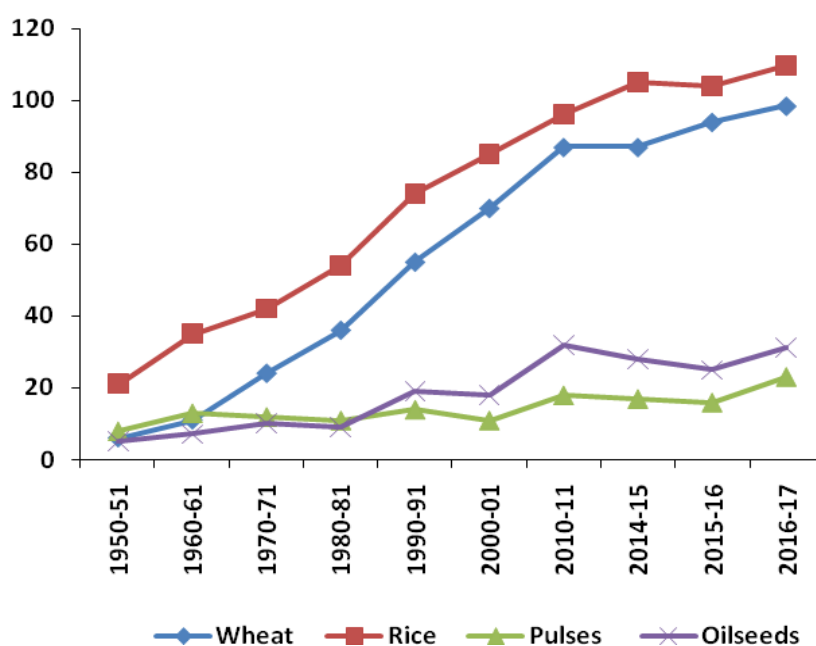


Figure 2. Agricultural Production (million tones)
(Source: Directorate of Economics and Statistics, 2017 and 2018)

For in-depth understanding of the risks related to India's agriculture, it is pertinent to analyse it from the perspective of crop cycle, which has been explained as below:

Seed Selection: The most important step towards getting good crop yield is seed selection. It should be ensured that good quality seeds are selected based on the cultivation environment. This will ensure increased germination, improved yield, resistance to pest and disease infestation or even drought. Seed selection is also done considering the preferences of the market and therefore, it should also be ensured that high yielding variety seeds are selected.

Land Preparation: Land preparation is done to bring the land to optimum condition for growing crops. Primary and secondary tillage operations are done to pulverize the soil so that the crops can develop a good root system. Also, a well prepared land helps in controlling weeds and recycling of nutrients. Land preparation is mainly done with farm machines but a small percentage of farms also use cattle and buffaloes.

Crop Establishment: It includes both direct seeding and transplantation. Depending on the type of crop, seeds are sown directly in the soil or transplanted. During this stage, nutrients are also provided so that the plants get germinated fast, have good establishment and also to ensure that the plants don't get wilted.

Irrigation: The artificial application of water to land for agricultural production is defined as irrigation. From the definition, it can be understood that irrigation is very important operation in the crop cultivation cycle. Effective irrigation will help in proper germination, root and growth, proper utilization of nutrients, and thus realizing good production.

Crop Growth: After the establishment crops are exposed to certain hazards, like pest and insect infestation, attack by rodents, etc. The plants need to be protected from hazards by taking up precautionary measures like using pesticides or insecticides and providing nutrients. The farmers should adopt proper time, frequency and method for applying fertilizers and manures. Also, for better

and fast crop growth, farmers should reduce density of the crop to optimum as per the agronomic recommendations for the region.

Harvesting: The process of cutting the crop and gathering from the field is a very important stage. Depending on the type of crop grown, the time of harvesting also differs. Crops are either harvested manually or using farm equipments/machineries depending upon the type of crop.

Post Harvest Processes: The harvested crops are stored in the storage structures. The storage structures and also the time of storage differ from one crop to another. For example, grains are usually dried after harvesting and are stored for longer duration. However, vegetables and fruits are stored for shorter duration. Other processes like cleaning, milling, packaging, marketing, etc., also comes under this stage.

Figure 3 illustrates the process of crop lifecycle, resources associated with each phase of cropcycle and related hazards capable of disrupting the process of crop cycle.

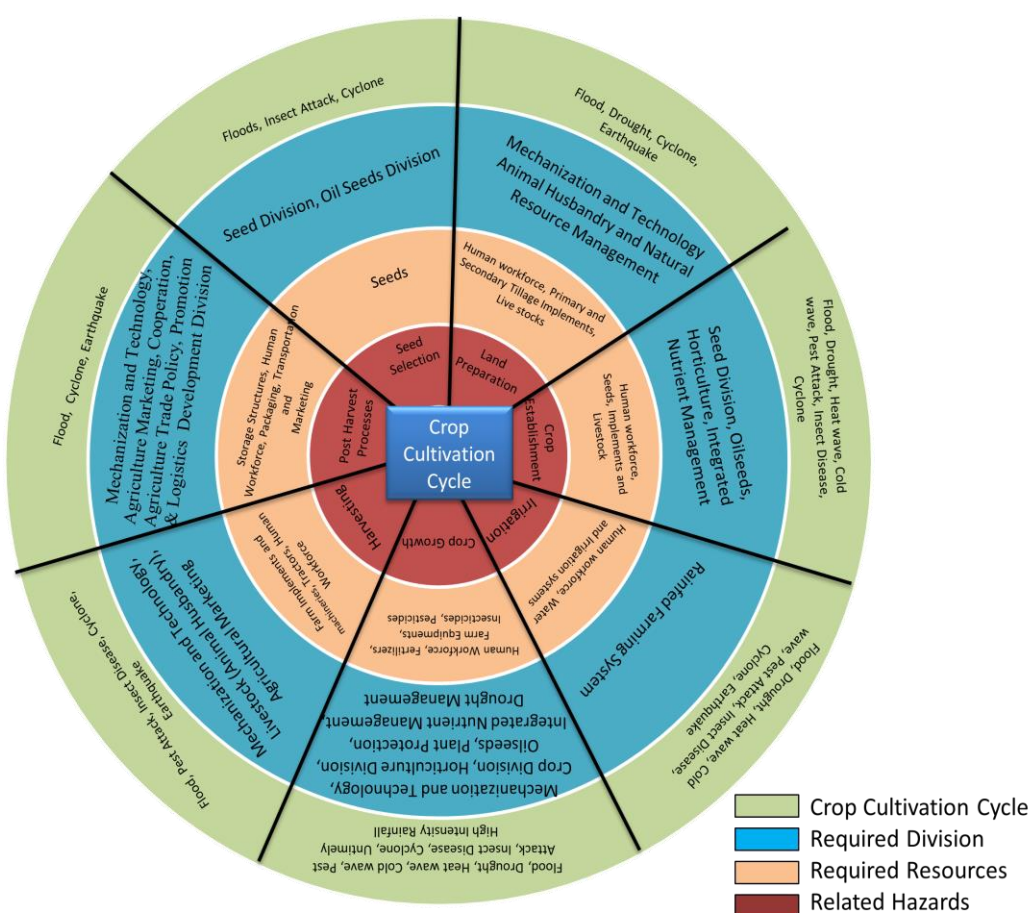


Figure 3: Crop Cycle and Associated Hazard

Challenges of Indian Agriculture

The Indian Government has set a target of doubling farmers' income by the year 2022, 5 trillion dollar economy and ease of living by 2024. However, these targets can only be achieved by improving the risk scenario of Indian agriculture and protecting it from natural disasters through proper adaptation or mitigation. Indian agriculture, like India's landscape is vulnerable to multiple natural and

anthropogenic disasters and is also aggravated by the impact of climate change. Unlike anytime in the past, India's agriculture challenge has to be understood concurrently in many dimensions. Some of the challenges are addressed below:

Crops

Regardless of high agricultural production, yield of many crops is lower than in developing countries like Brazil, China and USA. According to Food and Agriculture Organization of the United Nations (FAO,UN), even though India is the second highest rice producer in the world (as of 2013), its yield is lower than China, Brazil and USA and same is the case for pulses. Figure 4 shows the average yield of rice, wheat, other cereals and pulses in India vis-a-vis other countries. The average yields of many of the crops in India are among the lowest in the world with 30-50% lower than the developed countries (Despande, 2017).

The reason for the low yield is that Indian soils have been used extensively for growing crops over thousands of years without being replenished which has led to depletion and exhaustion of nutrients resulting in low productivity. There are other numerous reasons for yield reduction of which some are poor infrastructure, inefficient farm technologies and farming techniques, average farm size, poor quality seed and irrigation facilities. To obtain superior crop yield, the most important input is seed quality which is out of reach to most of the farmers. As the monsoon rains are highly fluctuating and unpredictable in India, the area of crops under irrigation has to be increased from the present level (53%).

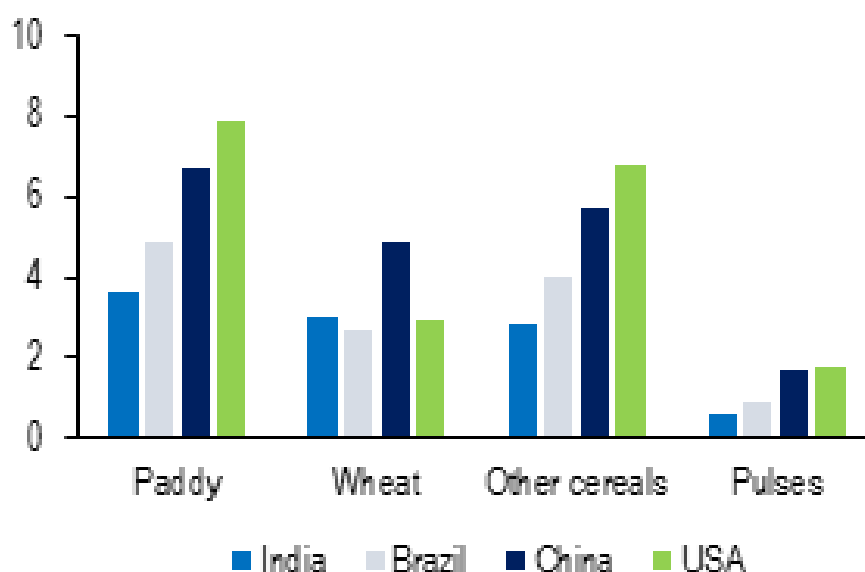
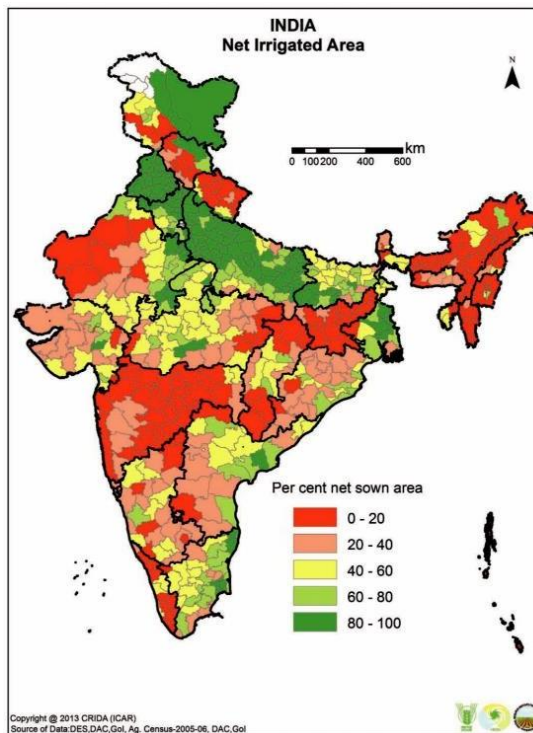


Figure 4: Yield in different countries in 2014-15 (in tonne/ha) Source: Food and Agriculture Organization of the United Nations; PRS 2017.

Weather

With the changing climate, Indian agriculture is at high risk, which is very much dependent on the weather. One major parameter is rainfall whose pattern is changing invariably and due to which there has been shift in cropping patterns. With the changing climate some areas experience temperature rise and intense rainfall and in some areas, decline in rainfall and temperature rise is experienced. Crops are most sensitive to high temperature especially at the reproductive stage and grain-filling/fruit maturation stage. The changing temperature, directly and indirectly, has significant effect on the agricultural production and economy of the country (Nengzouzam et al., 2019). IMD (2016) reported that significant warming observed over most of India except two regions where significant cooling is observed i.e. one to the east and one to the west in the region 23°N to 26°N (Figure 5). The trends of extreme weather events like drought and storms are more frequent in near future. The major challenge towards achieving better harvest and improve agricultural sector as a whole is to understand these weather changes over a time period, and thereby adopting and adjusting different management practices.

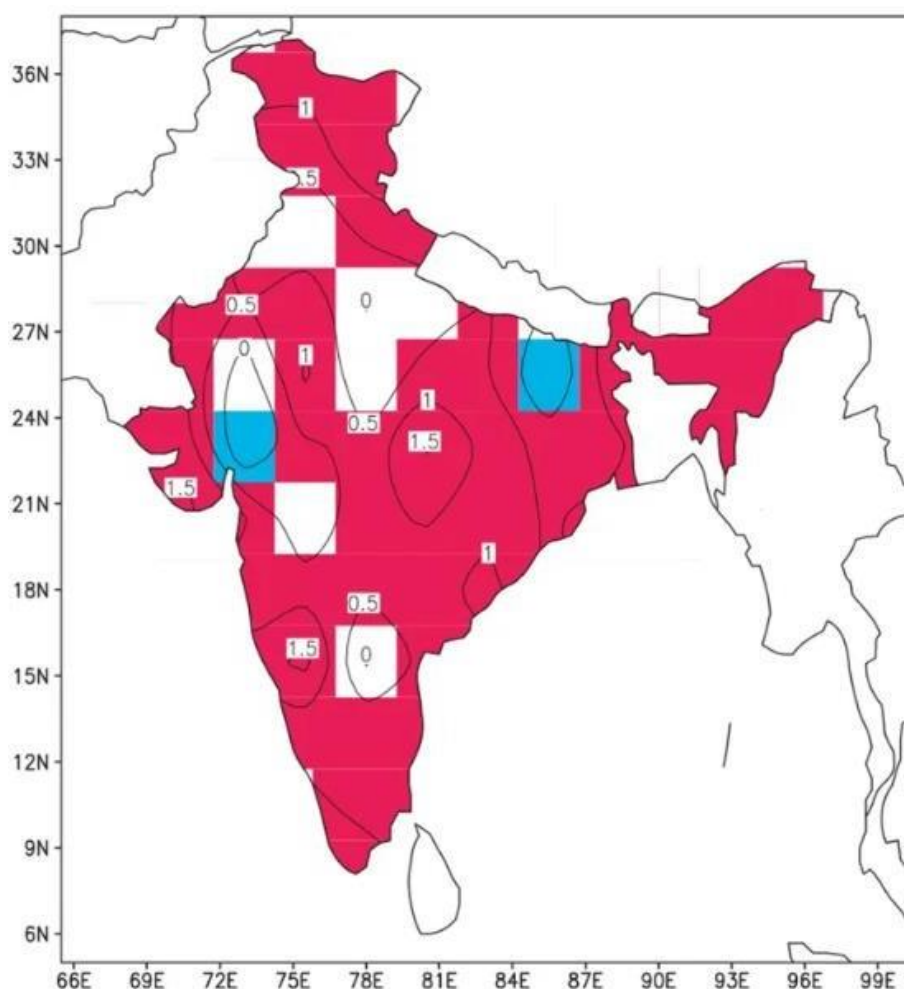


Figure 5. Annual mean temperature trends (C/100 years) over India for the period 1901– 2016. Values are shown as contour lines. Trends significant at the 95% level are shaded, with positive trends shaded in red and negative trends shaded in blue. (Source: IMD, 2016)

Land and Water

Soil and water resources are under immense pressure due to ever increasing population thereby ensuing growing demand for food, fiber and shelter. Soil and water resources are being deteriorated due to different anthropogenic and natural factors. Soil erosion is one of the major deteriorative processes which results in deterioration of the soil (Bashir et al., 2017).



The agricultural land is shrinking and degrading due to soil erosion, urbanization, deforestation, extensive cultivation, over-grazing, extreme weather events, desertification, etc. This is not only a threat to production level but it also has adverse implications for human health. The ever growing population along with the changing land use pattern is another factor of land scarcity. The loss of fertile land is also a threat to the amount of food production needed to feed the growing human population. India is also experiencing serious degradation and desertification. According to the report of SAC, ISRO, 29.3% of the total land is degraded in 2011-2013 in India, representing an increase of 0.57 percent (which is 1.87 million hectares in area) compared to 2003-2005. The driving factor for this land degradation is soil erosion by water and wind and degradation of vegetation cover. The strategies viz., strict land-use policy and better watershed management initiatives are needed to bring these degraded lands to arable.

Social Aspect

The social aspects around agriculture have also been noticing the changing trends of Indian agriculture. There has been an increased feminization of agriculture which is mainly due to increasing rural-urban migration by men, rise of women-headed households and growth in the production of cash crops which are labour intensive in nature. It is also known that women perform significant tasks both, on farm as well as non-farm activities and their participation in the sector is increasing but their work is treated as an extension of their household work, and adds a dual burden of domestic responsibilities (FAO, 2019). Cases of farmers suicide in India is witnessed often as natural disasters are occurring frequently, affecting their economic status as they are dependent on agriculture. Urban growth is also an important challenge that Indian agriculture is facing. Urban growth based on migration and the absorption of rural areas into the urban has led to issues ranging from impoverishment, water and sanitation insecurity, ill-health, malnutrition, loss of fertile land, food insecurity, social insecurity, gender inequality as well as over-concentration in slums and squatter settlements that also often get flooded as well as prone to other disasters (Gupta et al. 2017). Another social aspect is to increase the resilience of small and marginal farmers who are more vulnerable to agriculture related disasters. On small and fragmented fields, it is difficult to irrigate as some portion of land is lost to field boundaries. Educated farmers will have more awareness of the Government policies, plans, insurance schemes and use of farm implements, agromet advisories, access to agriculture websites and other agriculture related information services. With the adoption of farm mechanization, the farming becomes efficient and farm labour can be used efficiently for agricultural operations.

Disaster Related Challenges

The Indian agricultural sector is already threatened by existing stresses such as the limited availability

of water resources, land degradation, biodiversity loss and air pollution; Besides, it is one of the most disaster affected sectors whose activities are adversely affected by weather changes/variations in physical conditions resulting in huge economic losses and disruption of people's livelihood. One of the key drivers behind such increasing economic loss due to disasters is lack of appropriate disaster management including risk reduction strategy based on knowledge about hazard impacts and access to risk information. The increased frequency and severity of climate related hazards and risks induced by climate change are adding a new dimension to the existing disaster risk profile of Indian agriculture. Ministry of Agriculture in a recent report in 2018 stated that climate change is projected to impact agricultural productivity with increasing severity from 2020 onwards and could rise as much as 40% by 2100 unless appropriate adaptation measures are undertaken in the agriculture sector. India has diverse agro- climatic regions (Figure 6) and as such it is prone to different multiple disasters with respect to its zone. The agriculture disaster related challenges are highlighted as follows:

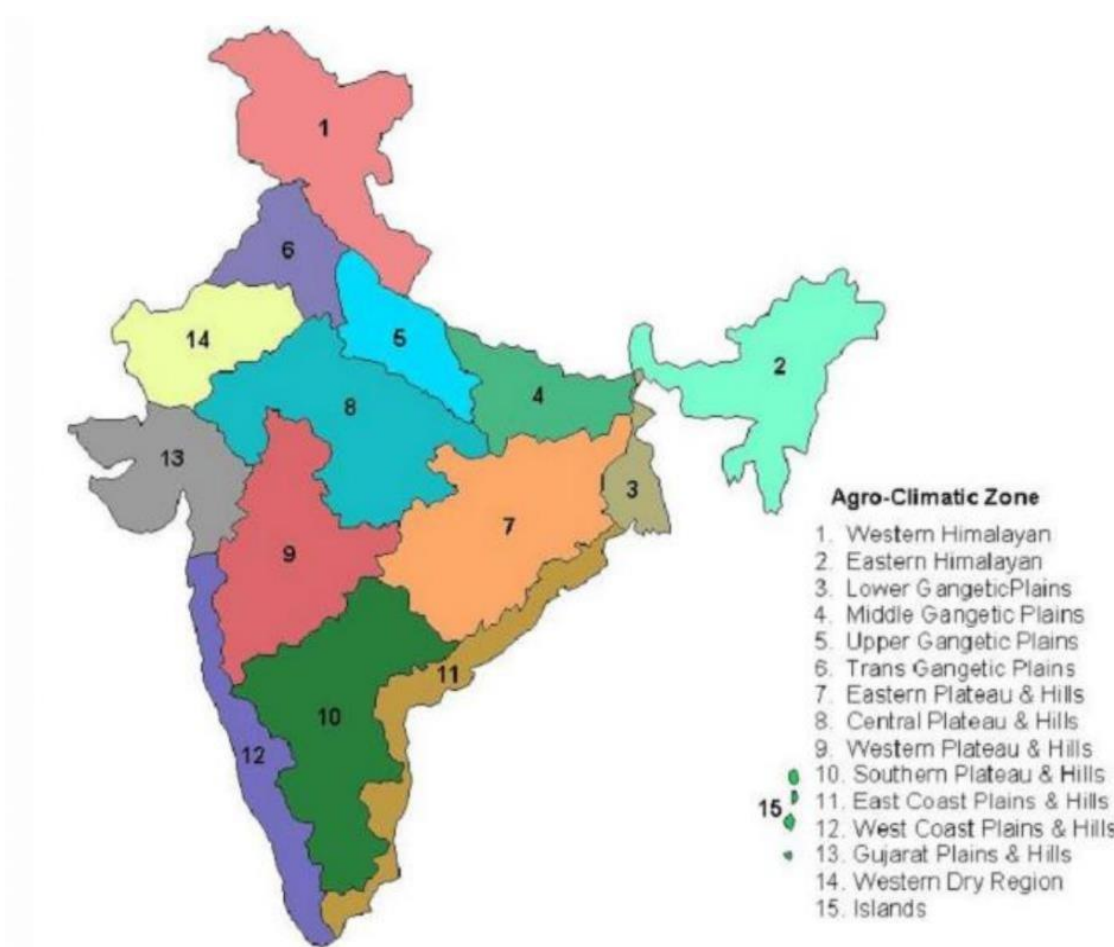
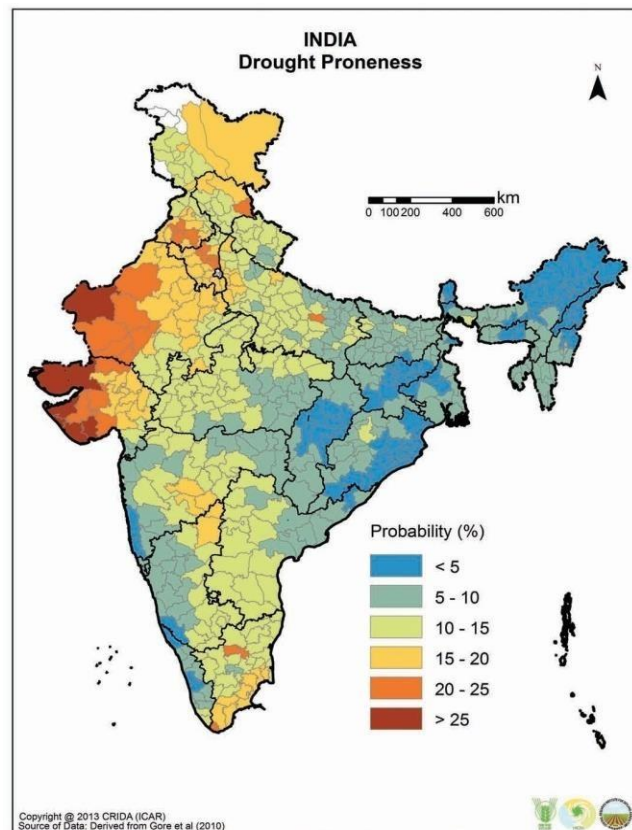


Figure 6. Agro-Climatic Regions of India (15 ACR) prepared by NITI Ayog

Drought

In a developing country like India, drought has a wide range of effects and its impact (physical, agriculture and socio-economic) is specifically conspicuous in view of the tropical monsoon character of the country. Since agriculture is the backbone of Indian economy, the impact on agriculture is to be given utmost importance. Indian agriculture largely depends upon monsoon rainfall where about two-thirds of the arable land lack irrigation facilities and is termed as rainfed. The effect is manifested in the shortfalls of agricultural production in drought years (Mohita, 2013). More than 68% of net sown area in India is prone to drought, which varies temporally and spatially. Agriculture drought often leads to decline in sown area, decreasing the production, fall in purchasing power, rising unemployment, water scarcity, inflation, widespread malnutrition and spread of diseases. Drought is a complex and least understood natural disaster, the impacts of which often depend upon the nature of socio environmental background in the region, and affects more people than any other disaster (Gupta and Sehgal, 2011).



Flood

In addition to drought, flood is another important challenge that affects agriculture sector. Under the influence of climate change and economic development, the extent of floods is expected to increase (Jonkman and Kelman, 2005; IPCC, 2007). The tangible and intangible losses due to floods in India are increasing due to over population and increased habitation, cultivation and other developmental activities. Indian agriculture has experienced massive losses like crop losses leading to reduced yields, erosion of top fertile soil, damage to machineries, stored inputs, roads, etc due to floods. Agricultural areas are frequently located in floodplain areas and therefore, this area is particularly targeted. Climate change is also another driver which intensifies the hydrologic cycle thereby increasing the magnitude and frequency of extreme floods. A report stated that land-use issues like decreased natural areas, loss of water bodies, encroachment of river/streams and other drainage channels, uncontrolled multiplication of built-up areas, are contributory factor to flood risk (Gupta and Nair, 2011).

Cyclone

All the components of agriculture sector specially those which are in coastal areas are affected by cyclone through direct damage by high speed wind, torrential rain and extensive flooding. High tide may also affect the agriculture by bringing in saline water and sand mass making the fields unsuitable for agriculture. The indirect effects include pest and disease infestation to crop plants. Agricultural marketing and trade of crop, fish and animal production is adversely affected



Banana trees destroyed by Cyclone Gaja in Tamil Nadu. Source: The Indian Express, 2018

due to damage of infrastructure. Past cyclones have devastated the crops and resulted in huge monetary loss in the country. Super cyclone in 1999 and Phailin in 2013 severely affected crop production and livelihood of farmers in Eastern Coast of India (Rautary et al., 2014). Recently, Cyclone Fani's damage to standing crops was estimated to peg at around 150 crores (Jebaraj, 2019). As such, Government's support is needed for recovery of agriculture when such disaster happens.

Hailstorm

Hailstorm is another natural disaster which is a threat to Indian Agriculture. Hailstorm with powerful winds can physically damage crops across large areas. A small piece of hail can even destroy vegetables like cabbage, lettuce, tomatoes, etc. Thus, farmers suffer huge losses due to this natural disaster (Nag, 2018). The rural households are the ones badly affected by hailstorms especially who are uninsured and potentially unexpected income shocks.

Heatwave / Coldwave

The effect of extremes (heat waves and cold waves) has been rising in India and in the past two years these extremes has increased manifold leading to reduced crop yields. Guleria and Gupta (2016) stated that heat waves affect the crop production both quantitatively and qualitatively due to flower drop and higher mortality in new plantations. It is also reported that extreme change in temperature affects the productivity of both Kharif and Rabi crops. Small and marginal farmers are more affected by heat waves and cold waves. The extent of damage caused by cold wave depends on temperature, length of exposure, humidity levels, and the speed at which freezing temperature is reached. It is difficult to predict a definite temperature level up to which crops can tolerate cold wave/frost because many other factors also affect it. Different crops affected by cold waves in North in 2006 are shown in Figure 7.



Papaya



Wheat



Jatropha



Mustard



Mustard



Ice formation on leaves

Figure 7. Impact of cold wave in North – 2006 (Source: ICAR-CRIDA, 2012)

Pest Infestation

Any harmful organisms that latch on to plants compete for nutrients and rendering them unsuitable for harvest are pests. Insects constitute the most dangerous pests causing significant damage to agricultural and horticultural crops. Our farmers have been battling pests on the field since ages. When we talk about pests it could be anything that is harming the agriculture crops like weeds, insects, mites, rodents, animals and birds. However, the most dangerous of all the pests is insect pests which cause damage on stored products mainly by direct feeding. Some species feed on endosperm causing loss of weight and quality, while other species feed on the germ. Such infestations/damages can be prevented by seed treatment, building healthy soil, planting of resistant variety of crops, row spacing, timely planting, crop diversification and rotation, and spraying natural pesticides. One of the recent pest incidences was the fall armyworm attack on maize (Figure 8) in Karnataka which later invaded crops in more than 9 states. Scientists from National Rice Research Institute have reported that rise in temperature and humidity makes congenial environment for pest growth and development.



Figure 8. Fall army worm attack in farmers' field in Adilabad, Hyderabad (Source: Singh, S.H. The Hindu, 2019)

Post Harvest Losses

Most often, the post harvest losses from natural disaster are neglected. It is not only the standing crops that are being destroyed but also harvested crops stored in the silos, agriculture farm houses, etc. are also affected. Farmers have very poor storages and transportation facilities which becomes more critical for perishable fruits and vegetables. Reports showed that about 34% of fruits, 44.6% of vegetables and 40 of combined fruits and vegetables were unsold in the market (Pandey, 2018). As such, there should be proper and sufficient storage structures where natural disasters can not affect them and the agro-processing facilities should preferably be located close to the points of production in rural areas.

Remedial Strategies

Historical Perspectives

India, due to its weather, geographical location and physical features is susceptible to disasters like flood, drought, etc. and many of the farmers lay in the disaster prone areas. One way to deal with such situation is to be prepared for it following the remedial strategies. The Indian Government has developed several contingency plans to handle such natural disasters. The government also provides compensation and other financial aid to farmers who are affected by natural disasters so as to reduce cost of production and to improve their socio-economic status (NPCMT, 2011). In 1943, World's worst recorded food disaster occurred in India which is also known as Bengal Famine which left around 4 million people die of hunger. This has led to introduction of Green Revolution in India and food security became one of the main items in India's Agenda. The Green Revolution was started in 1965-66 with the aim to introduce high yielding varieties, supported with fertilizers, pesticides and newer agronomic practices. The basic three elements of green revolution were continuing expansion of farming areas, double-cropping in the existing farmland and using genetically improved seeds. The second Green Revolution not only focuses on enhancing agricultural production but also on generation of employment for the small and marginal farmers and the landless. Almost all the agricultural policies are covered under second green revolution.

Agriculture Policies Related to Disaster

Farmers are provided with necessary support, encouragement and incentives to ensure all-round development and economic viability of agriculture. Such policies include income from on farm and off farm job activities. There is also compensation from the Prime Minister's National Relief Fund to the next of kin of those killed in natural disasters. Integrated Pest Management (IPM) Scheme works significantly better for crop protection. The National Plant Protection Training Institute (NPPTI) in Hyderabad is the concerned authority that provides training in plant protection. Pradhan Mantri Fasal Bima Yojna (PMFBY) provides financial support to mitigate the losses caused by natural disasters like floods, drought, crop diseases and attacks by pests, etc.

Disaster Management Strategies

Agricultural sustainability implies the maintenance of the quality and quantity of agricultural produce over very long periods of time. A report on sustainable agriculture stated that there are four important aspects to be interrelated and considered in sustainable agriculture and they are: changing human needs overtime, appropriate natural resource management practices, maintenance or enhancement of quality of environment and conservation of genetic diversity resources (Gupta, et al. 2004). Though, there is visible improvement brought through adoption of management practices through on-farm and off-farm operations in this sector, there is also growing risk of disaster related damages and losses to the

agriculture systems. The severity and frequency of climate hazards are also increasing and it is expected that by 2020 the increase in severity will have adverse impact on agricultural activity. Considering the need of nation, its people and businesses, taking action towards climate resilient agriculture is crucial for better livelihood, food security and health.

Drought Management

Over the past years, drought management strategies of India have contributed to overall development of the country. In the last few years, India has shifted its review focus from relief centric to the present drought risk management strategy which includes institutional mechanisms, employment generation and social welfare practices, community participation and operation of EWS (Gupta, et al. 2011).

Institutional Mechanism

The institutional mechanisms that ensure coordinated action across different ministries are the National Disaster Management Cell (NDMC), National Centre for the Calamity Management (NCCM), National Disaster Response Force (NDRF), State Disaster Response Force (SDRF), Crop Weather Watch Group and National Agriculture Insurance Scheme (NAIS). NDMC monitors drought situations, NCCM monitors all type of calamities, NDRF and SDRF were formed under Disaster Management Act, 2005 and they provide immediate drought relief to the affected people and NAIS provide financial support. Other Institutions like Central Research Institute for Dryland Agriculture (CRIDA) with its network centers on All India Coordinated Research Project for Dryland Agriculture (AICRPDA) and Agrometeorology (AICRPAM), Indian Agricultural Research Institute (IARI); Central Arid Zone Research Institute (CAZRI); Indian Council of Forestry Research and Education (ICFRE) etc. are also involved in drought management. A schematic description of drought management cycle in India is shown in Figure 9.

Employment Generation and Social Welfare Practices

The Indian Government started several schemes that helps in employment generation of drought affected people are Food for Work Programme, Employment Assurance Scheme (Rs 16.0 billion), Jawahar Gram Samridhi Yojana (Rs 16.5 billion), Pradhan Mantri Gram Sadak Yojana (Rs 5.0 billion), Antyodaya Anna Yojana, National Old Age Programme, Annapurna Scheme (Rs 3.0 billion), Integrated Child Development Scheme and Mid-day Meal – school children.

Community Participation

Government's effort can be made effective through community participation. The various approach which involves communities are relief works by Gram Sabha/Panchayat, Districts and Block-level committees who are involved in sanctioning and monitoring of relief works, NGOs who plays a significant role in training and motivation.

Operation of Drought Monitoring and Early Warning Systems (EWMS)

Drought monitoring and declaration and drought forecasting are two important components of EWMS. For drought forecasting and early warning, IMD and the National Centre for Medium Range Weather Forecasting offer meteorological information. For drought monitoring, the National Agricultural Drought Assessment and Monitoring System (NADAMS) project provides near real-time information on prevalence, severity level and persistence of agricultural drought. The Crop Weather Watch Groups at Centre and in respective States are the institutions which monitor the drought situation and its impacts. The drought declaration has been made objective based on observations of meteorological, crop remote sensing and hydrological parameters as described in the Manual of Drought Manual – 2016.

Associated Policies/Schemes

Some of the other agriculture associated policies are given below in Table 2.

Table 2. Schemes/ Policies under Ministry of Agriculture and Farmers Welfare

Sector	Schemes/Policies
Crop Related	Pradhan Mantri Kishan Samman Nidhi
	Krishi Unnati Yojna
	Rashtriya Krishi Vikas Yojna
	Pradhan Mantri Krishi Sinchai Yojna
	Ground Water Irrigation Scheme
	Pradhan Mantri Kisan Sampada Yojna
	Pradhan Mantri Fasal Bima Yojna
	Pradhan Mantri Annadata Aay Sanrakshan Abhiyan
	Manual for Drought Management - 2016
	Scheme for Conservation, Development and Sustainable Management of Medicinal Plants.
	Jute Development Schemes
	Agriculture Marketing Infrastructure
	Scheme of Seeds
	National Agroforestry Policy
	National Certification System for Tissue Culture Raised Plants
	Biotech-KISAN Scheme
	Agricultural Mechanization for in-situ Management of Crop Residues
	Protection of Plant Varieties and Rights of Farmers
	Model Agriculture Land Leasing Act 2016
Rural Employment Related	Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGA)
	Prime Minister's Employment Generation Programme (PMEGP)
	Agri Clinics and Agri Business Centres Scheme
	Rajiv Gandhi Udyami Mitra Yojana (RUGMY)
	Scheme of Fund for Regeneration of Traditional Industries (SFURTI)
	Rural Industry Service Centre (RISC)
Water Related	Coir Udyami Yojna
	Jal Shakti Abhiyan
Energy Related	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM Kusum)

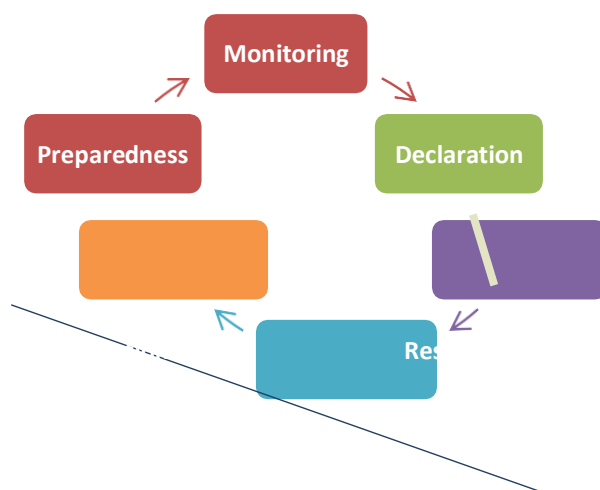


Figure 9. A schematic description of drought management cycle in India

Drought Proofing

Drought proofing means the capacity to meet the basic material and physical needs of the local population - human and animal - in a drought period so that there is minimal distress. It includes an area of local natural and human production resource base that can provide a certain desirable amount of food, fuel, fodder, drinking water and livelihood resources during a drought. Water availability, water use and entitlements are the three basic elements of comprehensive drought proofing.

Crop Modification

Several studies have been conducted to identify if genetically modified (GM) crops could be of help in offsetting the climate change effect on agriculture. Through GM technology, yield of crops could be increased by 6-30%; however application of GM crops in India in this context needs further scientific understanding to avoid mal adaptation. It helps in reducing greenhouse gas emissions, application of fertilizers, fuel use and ploughing. It is also reported that in 2013 alone GM crops contributed to reducing CO₂ emissions by 28 billion kg, equivalent to taking 12.4 million cars off the road for one year (Source: ISAAA Brief 49-2014: Executive Summary). Globally, water stress is affecting 1.5 to 2.0 billion people and under climate change condition, there will be flooding of low-lying areas to greater extent resulting in soil salinity and water logging. Under such condition, GM crops could be of major importance. First, GM versions of soybean, maize and cotton were seen to be successful in terms of pest control and yield improvement (Clement et al., 2011). Still, the technology needs to be tested for its long-term impact on health, environment and sustainability.

Soil and Water Management

Suitable soil and water management practices are very crucial for sustainable agriculture and better environment. The different schemes at village and watershed level that works on soil and water management are: National Mission for Green India (NMGI), Integrated Watershed Management Programme (IWMP), Mahatma Gandhi National Rural



Employment Scheme (MGNREGS). NMGI focuses on improving the quality of forest cover, MGNREGS focuses on land, water and afforestation activities and IWMP which is now known as Pradhan Mantri Krishi Sishya Yojna - focuses on development of 75 million hectares of rainfed/degraded area in a phased manner during 2007-2027. Also there are other in-situ and ex-situ soil and water conservation practices like percolation tanks, roof top water harvesting structure, farm pond, khadins, ahars, contour bunds, contour trenching, etc. For soil conservation windbreaks and shelter breaks can also be adopted. Different types of soil and water conservation measures are shown in Figures 10 and 11, respectively. Physical measures/ mechanical/ technical measures, biological/vegetative measures and agronomic measures are best management practices. Other than these, there are also traditional water management systems like Bhandaras in Maharashtra, Khadins in Rajasthan, Ahars in Bihar, etc. These systems are still prevalent today and National Water Policy of 2002 envisaged the rejuvenation these systems and also encourages the practice of rain water harvesting, including roof-top rainwater harvesting to further increase the utilisable water resources (Nair, et al.). There are also watershed development projects that have been taken up under drought prone areas program and desert developmental programmes of Government of India.

National Innovations in Climate Resilient Agriculture (NICRA)

To address the challenges of sustaining domestic food production in the face of changing climate, the Indian Council of Agricultural Research (ICAR), Ministry of Agriculture and Farmers Welfare, Government of India launched a flagship network project 'National Innovations in Climate Resilient Agriculture' (NICRA) in 2011. The project aims to develop and promote climate resilient technologies in agriculture which will address vulnerable areas of the country and the outputs of the project will help the districts and regions prone to extreme weather conditions like droughts, floods, frost, heat waves, etc. to cope with such extremes. The objectives of project are 1) To enhance the resilience of Indian agriculture to climatic variability and climate change through strategic research on adaptation and mitigation, 2) To validate and demonstrate climate resilient technologies on farmer's fields, 3) To strengthen the capacity of scientists and other stakeholders in climate resilient agriculture, and 4) To draw policy guidelines for wider scale adoption of resilience- enhancing technologies and options. A Vulnerability Atlas to climate change at district-level for 572 rural districts was prepared to address major vulnerabilities in the country. ICAR along with National Agricultural Research and Education System (NARES) has prepared District Agriculture Contingency Plans for 650 districts in India. Several climate resilient technologies have been developed over the past seven years and were demonstrated in 151 clusters of villages in each one of the identified climatically vulnerable districts throughout the country. Technology demonstrations are being implemented in 446 villages involving an area about 2 lakh ha with 1,83,753 households in 28 States. Demonstrations of such location specific proven technologies enhanced adaptive capacity of farmers and helped them to cope with current climatic variability.

The enabling environment was created in these villages by establishing village level institutions like Village Climate Risk Management Committee, Custom Hiring centers for Farm Mechanization, Seed Banks, Nutrient Banks, fodder banks, etc. This has enabled the farmers to enhance the adaptive capacity against climatic variability particularly drought and floods. Simultaneously, the capacity building is also given to primary stakeholders (farmers) and secondary stakeholders which resulted in sensitizing climate change impacts on agriculture and also to enhance the adaptive capacity. (NICRA Highlights, 2016-18). The experiences gained under NICRA are integrated into various district/national programmes by various organizations to scale out climate resilient practices. The learning experiences to cope with drought, floods and other extreme events can be integrated into

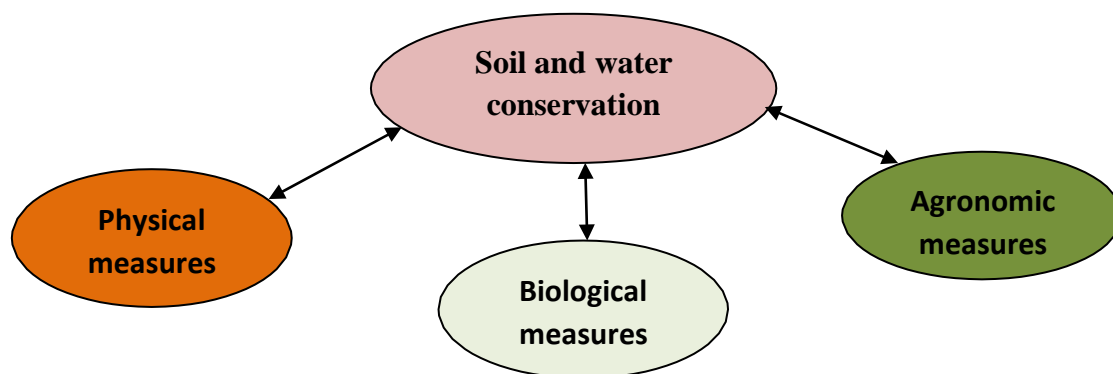


Figure 10. Types of soil and water conservation measures (Source: Krüger et al. 1997)

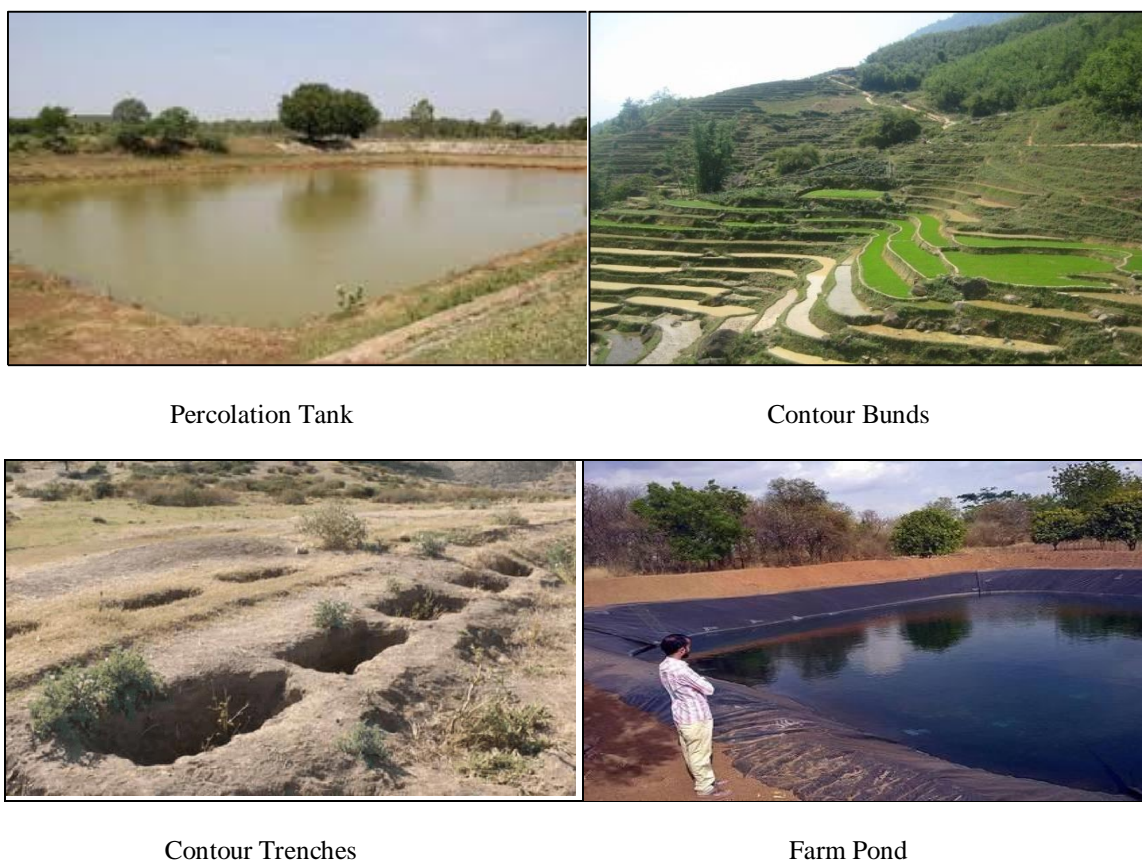


Figure 11. Different conservation structures (Source: The Hindu, 2018)

Need of NADMP and Legal Mandates towards It

In order to prevent the creation of new risks, reduce and mitigate severe effects of disasters, NIDM is preparing a National Agriculture Disaster Management Plan (NADMP) in accordance with the National Policy on Disaster Management, 2009. The vision of this Policy is to “build a safe and disaster resilient plan by developing a holistic, proactive, technological driven, and community based

strategy through a culture of prevention, mitigation, preparedness and response”.

While the national plan will pertain to disaster management for the entire nation, the hazard specific nodal ministries and departments notified by the Government of India will prepare detailed Disaster Management (DM) plans specific to a particular disaster. As per Section 37 of the DM Act, every ministry and department of the Government of India, including the hazard-specific nodal ministries, shall prepare comprehensive DM plans detailing their contribution in the domains of disaster prevention, preparedness, response, and recovery (NDMP, 2016).

Prime Minister’s Agenda 10 on Disaster Risk Management draws an integrated approach towards implementing the Sendai Framework for Disaster Risk Reduction, Paris Climate Agreement and the SDGs, through its Agenda 1, i.e. all sectors to imbibe the principles of disaster risk management, and utilizes the legal mandate under the Disaster Management Act 2005 and the National DM Policy 2009. National Institute of Disaster Management (NIDM) is mandated under DM Act, 2005 to support Government/Ministries and related agencies in developing their policies, plans, capacity building and research in DM.

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