Adaptation and Mitigation Strategies to Climate Change in Rainfed Areas

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1.0 Introduction

Rainfed agriculture in India is practiced over 85 m.ha area, while the total net cultivated area is 142 m. ha. Though, rainfed agriculture contributes 44% of food gain production its contribution in coarse cereals, pulses, oilseeds and cotton is about 91%, 91%, 80% and 60% respectively. Significant amount of livestock population (66%) is also dependent on rainfed areas. The green revolution was the principal instrument in imparting dynamism to agricultural growth. Modern agricultural technology developed and extended since independence has contributed to unprecedented growth in the agricultural productivity in the country. Green revolution, however, mainly concentrated on the irrigated areas and therefore, by and large bypassed the rainfed regions till the 1970s. Rainfed agriculture is complex, diverse and risk prone and is characterized by low levels of agriculture productivity and low input usage resulting in nearly half the level of food grain yield compared to the irrigated region. Dependence on rainfall makes crops production considerably unstable in rainfed areas, which are the habitat of the bulk of rural poor and livestock in the country. Rainfed areas are further subjected to large scale soil degradation problem and rapid depletion of ground water tables which may further deteriorate the production levels in these thirsty and unhealthy soil conditions. There are technologies available for stepping up the productivity and production levels in the rainfed areas in a sustainable manner. In order to exploit the available potential for stability and growth of agricultural production and to achieve the various national objectives like reduction in regional inequalities and poverty, creation of income generating and productive employment opportunities and improvement of ecological balance a systematic and strategic approach is required for holistic development of rainfed areas.

1.1 Major issues and constraints in rainfed agriculture

An insight into the rainfed regions shows a grim picture of water scarcity, fragile ecosystems and land degradation due to soil erosion by wind and water, poor soil nutrient levels, low rainwater use efficiency, high population pressure, poverty, low investments in water use efficiency measures, poor infrastructure and inappropriate policy support. The greatest distress to farm and rural communities occurs in areas with low and uncertain rainfall. These areas occur mainly in the arid and semi-arid regions of the country. The people living in such environmentally under privileged areas had over centuries developed methods of coping with natural calamities. Migration with their cattle or sheep was one common method of withstanding the problem of water, food and fodder shortage. Women often stayed behind and had developed fairly effective methods of saving whatever food, fodder became available and sharing it equitably. Despite various schemes of Government of India, State Governments and the Externally Aided Projects, the fate of farmers' in rainfed areas continues to remain a gamble with the monsoon. Rainfed farming continues to be critical for meeting the livelihood needs of a vast majority of small, marginal and tribal farmers who mostly live in such areas of the country. The benefit of development of new technologies related to crops, resource management, livestock, and fisheries have not filtered down amongst farmers in rainfed areas to the extent that this has happened amongst farmers in irrigated areas. This is mainly due to the low and fluctuating productivity as well as the low risk bearing capacity of the rainfed farmers, for whom risk aversion is more important than productivity enhancement.

Low rainwater use efficiency and the constant threat of water scarcity and consecutive droughts further aggravate the situation. Land degradation and declining soil health, acute fodder shortage and poor livestock productivity are the other serious constraints. The challenges are further compounded by a large number of institutional and infrastructural deficiencies like lack of assured and remunerative marketing opportunities.

Agriculture in rainfed areas continues to be a gamble and rainfed farmers face several uncertainties like aberrant weather, lack of timely inputs and credit leading to low and unstable productivity and profitability. The inherent risks are high because i) rainfall is erratic and uncertain, ii) soils are degraded and poor in fertility, iii) farmers' economy is fragile with little resilience and iv) holdings are small and scattered. Against this backdrop, drought is a recurring phenomenon. The problems of the rainfed areas are currently getting enhanced as a result of the adverse effects of climate change, which has a stronger influence on the rainfed area production and productivity.

1.2 Droughts and Desertification

Studies show that more intense and longer droughts have been observed over wider areas since 1970's, particularly in the tropics and subtropics (IPCC, 2007). Increased drying linked with higher temperatures and decreased precipitation has contributed to changes in drought frequency and intensity. Changes in sea surface temperatures (SST), wind pattern and decreased snow pack and snow cover have also been linked to droughts.

Impacts of shifts in climatic pattern become more prominent when one considers the climatic spectrum of the dryland and arid regions as these marginal areas provide early signals of the impacts of climate variability and change (Ramakrishna, 2007). The rainfed regions encompassing the arid, semi-arid and dry sub-humid regions (covering regions less than 1150 to 1200 mm) are more prone to climatic variability as in these ecosystems drought is a regular part of the natural cycles affecting productivity and leading to desertification.

Rainwater management is the key to the success of rainfed agriculture. *In situ* moisture conservation, harvesting the runoff and efficient water use are important. Transforming *ex-situ* water harvesting systems for more groundwater recharge at micro basin level and increasing water productivity become priorities for any further development of agriculture in rainfed areas. Even the completion of envisaged river linkage project covering various parts of India, it is estimated that 50% would still remain dependent on monsoon (rainfed). Thus the projected changes in temperature, precipitation (quality and distribution) would significantly affect the rainfed areas and enhance the frequency of droughts and floods.

2.0 Adaptation and Mitigation Strategies to Climate Change

In the absence of any assured irrigation facility in rainfed areas and with ever growing changing patterns of temperature and precipitation, the rain water management technologies would play a greater role in rainfed areas. Renewed focus with incentive measures for *in-situ* management especially in low to medium rainfall regions with farmers themselves taking the leadership in conservation should be the focal theme. The predominant interventions to overcome climate related impacts in rainfed areas include

- Soil and water conservation practices

- Agronomic interventions
- Nutrient management practices
- Livestock based interventions
- Development of alternate land use plans

These interventions have a role to play in all agro-ecosystems except that their order of priority changes, which basically depends on rainfall, status of natural resources like soil, water etc. Crop based interventions need to be planned based on amount and distribution of rainfall, availability and further augmentation of water resources with watershed programme and NREGP.

2.1 Farming in Relation to Rainfall

Based on the resource availability, broad guidelines for natural resource management on watershed mode are given below:

For regions with rainfall less than 500mm: Priority should be given for ensuring drinking water facility even during lean season. In *situ* conservation coupled with farm/field boundaries should be given emphasis. Deep soils only should be encouraged for cultivation. Livestock based farming system should be encouraged. Fodder needs can be met by growing grasses in soils with low to medium soil depth. Runoff harvesting can be possible only if watershed receives runoff from upstream areas.

Rainfall (500-700mm): Crops can be grown in medium to deep soils with high available water content. Runoff harvesting could be possible in few cases for critical/ supplemental irrigation. Horticulture can be promoted to a larger scale. Land capability based land use planning with emphasis on alternate land use need to be promoted.

Rainfall (700-1100 mm): Farming systems can be promoted. Medium to deep soils with medium to high available water content can be promoted for cultivation. Cropping and livestock based systems can be promoted. Runoff harvesting is possible on small farms also. *In-situ* conservation with water harvesting for supplemental irrigation can be planned within watershed. In few cases, residual moisture within fields or pre sowing irrigation for *rabi* crop is also possible and there is a need to explore the possibilities based on location specificity.

Rainfall (>1100 mm): In areas where the rainfall is more than 1100 mm is received through South West monsoon, integrated farming system with fisheries in medium to low lands of rainfed rice also can be encouraged.

2.2 Strategies for Development

Following are the various improved techniques and practices recommended for achieving the objective of increased and stable crop production in dryland areas.

Crop Planning : Crop varieties for dryland areas should be of short duration through resistant tolerant and high yielding which can be harvested within rainfall periods and have sufficient residual moisture in soil profile for post-monsoon cropping.

Planning for weather : Variation in yields and output of the dryland agriculture is due to the observation in weather conditions especially rainfall. An aberrant weather can be categorized in three types viz.

- Delayed onset of monsoon.
- Long gaps or breaks in rainfall and
- Early stoppage of rains towards the end of monsoon season.

Farmers should make some changes in normal cropping schedule for getting some production in place of total crop failure.

Crop Substitution: Traditional crops/varieties, which are inefficient utilize of soil moisture, less responsive to production input and potentially low producers should be substituted by more efficient ones.

Cropping Systems: Increasing the cropping intensities by using the practice of intercropping and multiple cropping is the way of more efficient utilization of resources. The cropping intensity would depend on the length of growing season, which in turn depends on rainfall pattern and the soil moisture storage capacity of the soil.

Fertilizer use: The availability of nutrients is limited in drylands due to the limiting soil moisture. Therefore, application of the fertilizers should be done in furrows below the seed. The use of fertilizers is not only helpful in providing nutrients to crop but also helpful in efficient use of soil moisture. A proper mixture of organic and inorganic fertilizers improves moisture holding capacity of soil and increase drought tolerance.

Rainwater management: Efficient rainwater management can increase agricultural production from dryland areas. Application of compost and farmyard manure and raising legumes add the organic matter to the soil and increase the water holding capacity. The water, which is not retained by the soil, flows out as surface runoff. This excess runoff water can be harvested in storing dugout ponds and recycled to donor areas in the server stress during rainy season or for raising crops during winter.

Watershed management: Watershed management is a approach to optimize the use of land, water and vegetation in an area and thus, to provide solution drought, moderate floods, prevent soil erosion, improve water availability and increase fuel, fodder and agricultural production on a sustained basis.

Alternate Land use: All drylands are not suitable for crop production. Same lands may be suitable for range/pasture management and for tree farming and let farming, dryland horticulture, agro-forestry systems including alley cropping. All these systems, which are alternative to crop production are called as alternate land use systems. This system helps to generate off-season employment mono-cropped dryland and also, minimizes risk, utilizes off-season rains, prevents degradation of soils and restores balance in the ecosystem. The different alternate land use systems are alley cropping, agri-horticultural systems and silvi-pastoral systems, which utilizes the resources in better way for increased and stabilized production from drylands.

3. MITIGATION OF DROUGHT

Drought is recurring phenomena and its occurrence cannot be avoided. However, its impact can be minimized through application of science and technology in developing suitable drought management plans. Generally, there are always some areas, which are not affected by drought while some other areas may be reeling under drought. Therefore, there is a need to develop infrastructure for mitigation of drought. Mitigation action specific to drought can be defined as short and long term action programmes or policies implemented in advance of drought that reduce the degree of risk to people, property and increase productive capacity.

3.1 Drought mitigation strategies

Some of the measures, which would help in effective response and mitigate the hardship of the people, are as under:

- Arrangement for reasonable buffer stock of food grain and fodder.
- Ensure supply of good drinking water in rural areas for human and livestock in drought affected areas.
- Assess fodder requirements in drought affected districts and locate areas where shortages are likely to occur and arrange supplies from outside.
- Fodder cultivation to be encouraged wherever feasible
- Rejuvenation of traditional rainwater systems viz., Nadis, Tankas, Khadnis, etc.
- Rainwater harvesting for both drinking and cropping.
- Management of human livestock population to reduce pressure on fragile arid ecosystem.
- Timely availability of credit, postponement of revenue collection and repayment of short-term agricultural loans.
- Appropriate land-use planning (Inter-cropping system), discouraging water intensive crop, and encouraging sprinkler and drip irrigation systems.
- Creation of local task force in each district to initiate relief measures immediately after the drought takes place.
- Implementation of crop and livestock insurance schemes.
- Provisions for cattle camp in drought affected areas.
- Early warning and drought monitoring should be carried out on the basis of long, medium and short term forecast.

3.2 Soil and Water Conservation Measures

Various soil and water conservation measures relevant for rainfed agriculture, which are key to cope with climate change and mitigate adverse impact include:

In-situ measures for rainwater management in rainfall areas.

- Off season land treatment:
- *Conservation furrows*
- *Ridges and furrows system in cotton*
- *Cover cropping*
- *Micro catchments for tree systems*

Medium term measures rain water management in rainfed areas.

- Stone and vegetative field bunds for soil and water conservation
- Graded line bund helps in efficient drainage.
- Trench cum bund for soil and water conservation

Long term measures for rain water management in rainfed areas

- Contour trenching for runoff collection
- On-farm reservoirs

- Ground water recharge structure (percolation tanks).
- Recharge through defunct wells.

4. Summary

Based on the rainfall regime, the above interventions can be prioritized. Before planning for long term measures, availability of runoff need to be assessed for ensuring judicious investment. Hence they may have scope with in the climatic region receiving more 800-900 mm rainfall. On the other, *in-situ* conservation measures have large scale applicability in every region as they ensure well distributed moisture regime and may provide succor against short term dryspells. While there should be continuous endeavour to ensure the rainfed areas to overcome from the fluctuations of monsoon due to climate change, it is also necessary to ensure the sustainability of the limited irrigated facilities available (through well, tank, small scale lift irrigation schemes) by following the improved methods of water management (furrow, sprinkler, drip), crop diversification towards low water consuming crops which may enhance the overall water productivity of rainfed areas. In order to bring awareness among the farming community on water availability and utilization pattern in watersheds, groundwater monitoring on watershed / hydrological unit basis through farmer participatory mechanism need to be promoted with proper water budgeting approach encompassing water needs for all sectors with in the watershed.

With the emphasis of watershed programs shifting from purely technical interventions to improve the livelihoods, the watershed programs need to be designed for more resilience to over come rainfall variability and climate change. An attempt is to be made to develop an upscalable and sustainable rural livelihood framework by achieving i) convergence of all the existing programmes at the district/cluster level including the National Rural Employment Guarantee Programme (NREGP) ii) linking the technical interventions on the watersheds with livelihood needs, iii) complementing the on-farm and off-farm livelihoods opportunities iv) understanding the institutional issues at the village level and evolving an enabling environment including capacity building v) create market linkages and evolve a dynamic interactive process between market needs and creation of new livelihoods, vi) and evolve a working model of public-NGO and private-partnership at the district level.

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