

Managing drought risk in rainfed agriculture

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Drought proneness is a key constraint to raising and stabilizing productivity in rainfed agriculture and hence managing drought is critical to the welfare of farmers practicing rainfed agriculture. Preparedness, management and relief are three important components of drought management policy. Efforts to address drought impacts on rainfed farming include both technological such as improved water management practices, developing drought-resistant crop varieties, and non-technological measures such as insurance, safety net mechanisms.

Keywords: Drought management, Perceptions, Rainfed agriculture

THE semi-arid lands of India represent most of the rainfed and deficit rainfall regions of the country. These make the regions more vulnerable to climate change and deficient rainfall leads to severe drought impacts. Drought is defined as a period of dry weather long enough to cause a serious hydrological imbalance. The UNCCD defines drought as 'the naturally occurring phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems'. Drought affects many economic and social sectors. Various disciplines have developed scores of definitions, and the approaches taken to define them also reflect regional and ideological variations. Both wealthy and developing nations experience significant repercussions from drought, although the effects are very different. Additionally, there are large differences in the capacity to deal with drought between nations and different regions, communities, and social groups.

Types of drought

Broadly droughts are classified into four categories, viz. Meteorological, Hydrological, and Agricultural and Socio-economic droughts. Meteorological drought is defined as 'A situation when there is a significant decrease (>25%) of normal rainfall over an area.' Meteorological drought, if prolonged, will result in hydrological droughts with marked depletion of surface and groundwater levels. Like in agricultural drought, there is no direct relationship between precipitation amounts and the status of surface and subsurface water supplies in lakes, reservoirs, aquifers, and streams because these hydrological system components are used for multiple and competing purposes, such as irrigation, recreation,

tourism, flood control, transportation, hydroelectric power production, domestic water supply, protection of endangered species, and environmental and ecosystem management and preservation. Agricultural drought occurs when both rainfall and soil moisture are inadequate during growing season to support a healthy crop. It is also the lack of availability of soil water to support crop and forage growth than by the departure of normal precipitation over some specified period of time. Socio-economic drought reflects the relationship between the supply and demand for some commodity or economic good (such as water, livestock forage, or hydroelectric power) that is dependent on precipitation. Supply varies annually as a function of precipitation or water availability. By affecting farm incomes, droughts also affect demand.

Impacts of drought in rainfed regions

As nearly half of net sown area is rainfed, agricultural production in India is highly dependent on quantum and distribution of rainfall. Drought reduces the country's food grain production in certain years by as much as 15-20% of the yield of a normal year. In India, irrigated agriculture has received greater priority than rainfed agriculture. The difference between these two types of agriculture has become even more with the green revolution. Drought impacts farmers' incomes as it can affect area under the crops and yield levels. Following crop failure, real incomes also frequently decrease as food prices rise. Small farmers and agricultural labour are most impacted. Droughts can occur after sowing, referred to as dry spells, results in farmers losing their investment in crop cultivation. Farmers also suffer as consumers as prices increase with a drought-induced production decline. Seasonal migration, increased

participation in labour market are also results of drought incidence. Table 1 lists important drought years in the country. Studies from Telangana and Karnataka have revealed that drought significantly affected the farm incomes. The severe drought in the Vijayapura district of Karnataka affected the *kharif* sowing by 42%. In the Nalgonda district of Telangana, there was reduction in yield of major crops, viz. chilli (44.35%), maize (41.67%), red gram (34.70%), cotton (30.41%), and rice (28.81%). A farm family on an average incurs a loss of ₹54,717/year during drought. Droughts significantly affect the crop yields and reduces the share of agriculture income to total family income, and farmers take the risk of diversifying their incomes by taking up non-farm activities to sustain themselves.

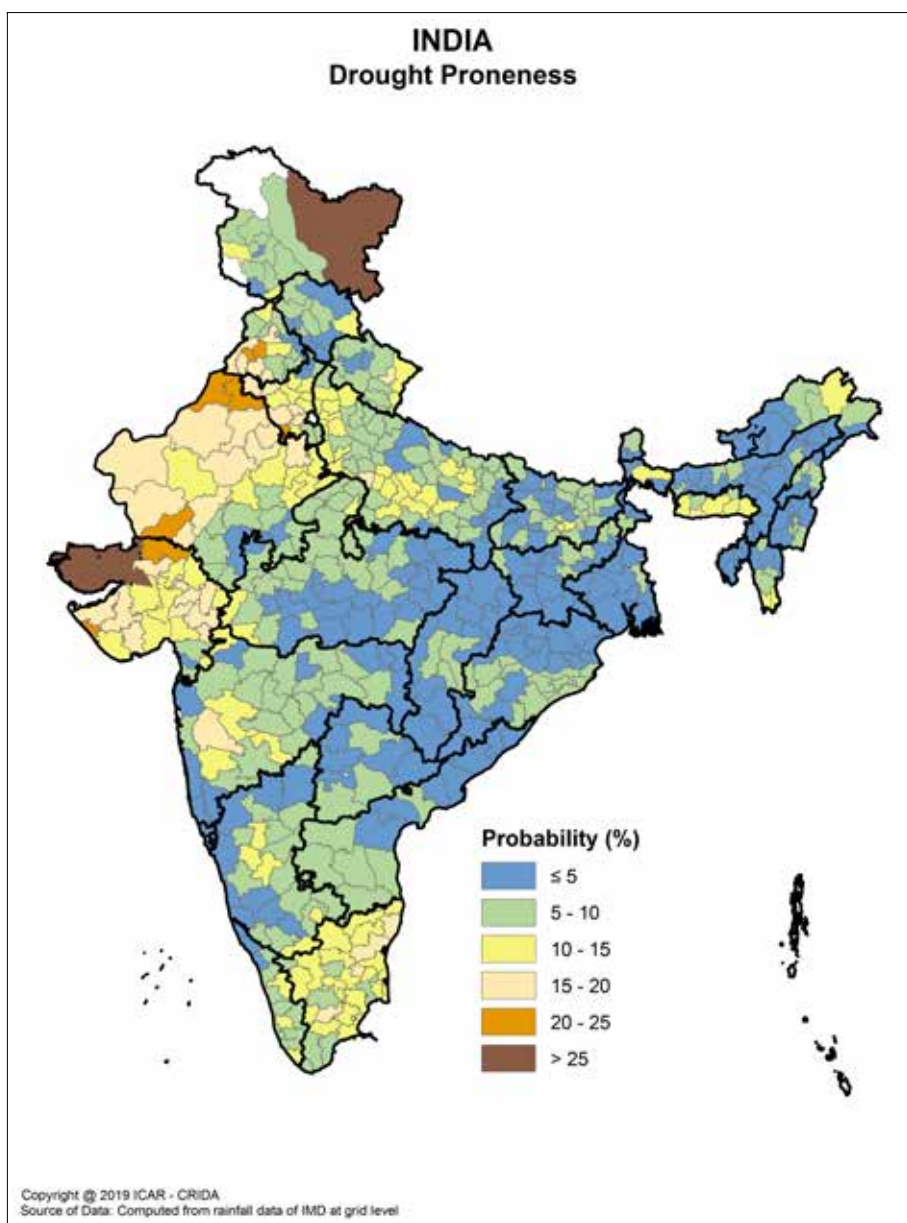
Why drought management?

Incidence of drought affects households and economies depending on the severity and extent of incidence. In India, though macro-level impacts are being increasingly better addressed, droughts continue to adversely affect household economies. The risk associated with drought for any region is the exposure to the natural hazard and the vulnerability of the society to its incidence. As incidence of drought is external to any economic activity, we can only implement strategies to reduce its impact. However, it is critically important for scientists to understand and communicate the probability of drought events. In general, a greater understanding of the natural hazard

Table 1. Historical occurrence of droughts and famines in India, 1800 onwards

Period	Drought years
1801-1850	1801, 1803, 1804, 1806, 1812, 1818-19, 1822, 1825-26, 1832, 1833, 1837, 1839, 1845
1851-1900	1862, 1866-67, 1867-68, 1868-69, 1871-73, 1877-78, 1878-79, 1883, 1891-92, 1896-97, 1898-99, 1899, 1900
1901-1950	1900-01, 1904, 1905, 1907, 1908, 1911-12, 1912-13, 1916-17, 1918-19, 1921-22, 1934-35, 1939, 1942-43, 1946, 1950, 1951
1951-2000	1960, 1965-66, 1972-73, 1977, 1978, 1979, 1982, 1983, 1985, 1987, 1988, 1992
Since 2001	2002, 2009, 2014, 2015, 2018

Source: IMF Climate Change Dashboard and Chuphal *et al.* (2020)



Probability of drought incidence (Source: Rao *et al.* 2019)

and human exposure to this climatic extreme and a better awareness of the micro and macro context of people's sensitivity to drought are important considerations in drought risk assessment. This knowledge will enable the identification and implementation of improved drought mitigation, readiness, and response strategies to build a more robust society to future droughts.

Drought management

Drought preparedness: The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current droughts.

Drought preparedness is crucial with increasing climate variabilities. The key areas that need to be in place are firstly to have an early warning system which is effective and timely, and it should be backed by remote sensing and GIS tools for monitoring drought conditions like soil moisture followed by

proper soil and crop management practices. Adoption of various soil and water conservation technologies, rainwater harvesting methods is an important element of preparedness. Farm level diversification in the form of agroforestry, integrated farming systems, etc. help smoothen income fluctuations. Community-based approaches like capacity building and training programs for participatory preparedness involving local farmers to identify context-specific drought strategies. The contingency plans are useful for preparedness and coping drought impacts. Drought monitoring and contingency plans are strategies to overcome drought-related problems faced by farmers. The district contingency plans, that list measures to deal with various manifestations of climate variability, were prepared for almost all districts in the country (<http://farmer.gov.in/>, <http://agricoop.nic.in/acp>). The implementation strategy of contingency plans involves (a) initial preparedness, (b) real-time response to weather aberrations, and (c) relief and rehabilitation.

Drought proofing: Adaptation and coping measures

Making available drought-tolerant crop varieties, providing access to irrigation, soil and water conservation measures, diversification are some of the measures for drought proofing. Equally important are putting in systems in place for weather forecasting, early warning and advising farmers. The climate-resilient

technologies have fetched 40% and more income resilience in dryland regions. Climate change adaptation brings substantial increase in profits to farmers and reduction in risk associated to climate extremes. The loss a farm household incurs during a drought year can be minimized by adopting climate smart agriculture practices. Adaptive measures are anticipatory in nature and coping mechanisms refer to those measures that are taken in response to incidence of drought. Changes in crop and varietal choice, conservation technologies, investments in irrigation are major adaptive measures whereas altering sowing time, mid-season corrections, consumption adjustments are examples of coping measures. Severe droughts can lead to erosive coping measures such as sale of assets, discontinuation of children education, increased indebtedness etc. which will have long term livelihood impacts.

Farmers' perceptions on preferred adaptation support for drought

The farmers in the west zone opined that the government and others should be investing in technologies for land development, rainwater harvesting and development of drought-resistant crop varieties; and should be complemented with policy measures such as improved access to credit, ensuring remunerative prices, capacity building and knowledge dissemination among different stakeholders and support to community-based organizations such as self-help groups. Improved

Table 2. Preferred adaptation support for drought

Zone	East	West	North	South
States	Bihar, Odisha, Jharkhand, Chhattisgarh, West Bengal	Gujarat, Rajasthan, Maharashtra, Madhya Pradesh	Punjab, Haryana, Uttar Pradesh	Andhara Pradesh, Karnataka, Kerala, Tamil Nadu
Technology related	Improved irrigation methods; Adoption of drought-resistant variety; Change in cropping pattern; Introduction of alternate crops; Improved soil management practices; Crop diversification and cropping systems	Land development; Rainwater harvesting; Improved irrigation methods; Promotion of organic manures; Adoption of drought-resistant varieties; Better crop management; Better soil management (bundling, terracing, strip farming, fallowing etc); Improvement of CPRs for grazing	Rainwater harvesting and better groundwater management; Improved irrigation methods; Adoption of heat and drought resistant varieties; Better crop/soil management; Change in cropping pattern;	Rainwater harvesting and better groundwater management; Improved irrigation methods; Adoption of drought and disease-resistant varieties; Better crop/soil management; Mechanization
Infrastructure related	Construction of dams; Electricity supply; Enabling life-saving irrigation; Bore well; Restoration of vegetation cover and replant trees for soil protection	Creation of irrigation facilities (bore wells)	Canal development	Creation of irrigation facilities; Better power supply
Policy related	Creating a coordinated decision structure; Improved drought forecasting and early warning system; Training and capacity building; Policy for equitable distribution of water	Timely and easy access to input markets; Capacity building and information sharing among stakeholders; Support to SHGs; Credit facility; Insurance; Investment in research and development; Awareness about organic farming; Promotion of animal husbandry	Credit facility; Insurance; Investment in research and development; Capacity building and information sharing among stakeholders; Policies for Income diversification; Water accounting/ budgeting; Improved drought forecasting and early warning system	Timely supply of inputs; Capacity building and information sharing among stakeholders; Remunerative prices; Market access; Credit facility (micro-finance); Insurance; Investment in research and development; Income diversification

Source: Rao et al. (2018)

Irrigation methods such as micro-irrigation and better coordinated administrative support are among the measures that the farmers thought was important in managing the drought situations in the country. Farmers wanted the government to focus on infrastructure-related measures such as the construction of irrigation dams, support to bore wells and better power supply. Restoration of vegetation cover was also one of the important measures expressed by farmers in the east zone. Farmers also wanted the government policies to pay attention to a more coordinated decision-making structure, early warning and forecasting measures and capacity building of stakeholders in dealing with drought. Supporting self-help groups, insurance, and diversification were also considered important by farmers.

Gender mainstreaming of drought management

Gender mainstreaming is very important in drought management, as men and women experience different levels of impact. Women are more prone to drought effects, as they have higher workloads managing farms and households with limited resource access. Governments have started various schemes to empower the farmers. *Mahila Shakti Kendra* (MSK) aims to empower rural women with skill development and employment opportunities. *Rashtriya Mahila Kosh* (RMK) is an apex micro-finance organization that provides concessional micro-credit to poor women for various livelihood and income-generating activities. Skill Upgradation and *Mahila Coir Yojana* is an exclusive training programme of MSME aimed at the skill development of women artisans engaged in the coir Industry. To promote female entrepreneurship, the Government has initiated Programmes like Stand-Up India and *Mahila e-Haat* (an online marketing platform to support women entrepreneurs/ SHGs/NGOs), Entrepreneurship and

Skill Development Programme (ESSDP). *Pradhan Mantri Mudra Yojana* (PMMY) provides access to institutional finance for micro/small businesses. These schemes help strengthen adaptive capacity of women and help enhance and diversify their incomes.

Government initiatives for drought management

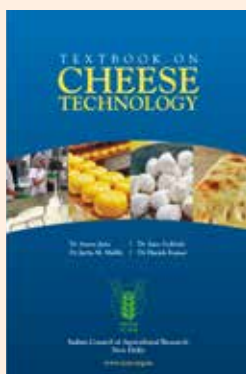
In India, both Central and State Governments have initiated many drought management programmes, including the National Drought Management Framework, *Pradhan Mantri Krishi Sinchayee Yojana* (PMKSY), *Pradhan Mantri Fasal Bima Yojana* (PMFBY), National Initiative on Climate Resilient Agriculture (NICRA), Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), National Adaptation Fund for Climate Change (NAFCC) and the National Water Mission. National Agricultural Drought Assessment and Monitoring System (N-ADAMS) is a recent initiative using satellite data for agricultural drought information and monitoring systems in India.

SUMMARY

Drought is a recurrent and challenging issue for India, particularly in its semi-arid and rainfed regions. With effective drought management strategies, including early warning systems, drought-resistant agricultural practices, and targeted policy support, the negative impacts of drought can be mitigated. However, there is still much to be done in terms of improving the resilience of rural populations and ensuring that adaptive strategies are well-coordinated across government, civil society, and the private sector. By strengthening preparedness and response mechanisms, India can better manage drought risks and ensure food security, especially in rainfed regions.

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