Rain-fed agriculture could meet the challenges of food security in India

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Rain-fed agriculture will play a major role in India's food security and sustainable economic growth, and there are large opportunities for gains from adaptation and new investments in water management for meeting the targets under the proposed National Food Security Act.

Of the 1.5 billion ha (11% of the world's land surface of 13.4 billion ha) of cropland worldwide, 1.223 billion ha (82%) is rain-fed[1]. These regions cover about 40% of the world's land area and host nearly 40% of the world's population. Further, about 70% of the world's staple food continues and will continue to be harvested from rain-fed areas, since the scope for further expansion of irrigation is limited due to growing competition for water and the high investment cost. The importance of rain-fed agriculture varies regionally, and is most significant in Sub-Saharan Africa, where it accounts for about 93% of farmed land, 87% in Latin America, 67% in the Near East and North Africa, 65% in East Asia and 58% in South Asia[2]. Most countries depend primarily on rain-fed agriculture for their foodgrains. About 30% of the world's land surface, or 4.2 billion ha, is suitable for rain-fed agriculture[1]. Therefore, upgrading rain-fed agriculture promises large social, economic and environmental paybacks, particularly in poverty reduction and economic development.

India ranks first among the countries that practice rain-fed agriculture both in terms of extent and value of production. Out of an estimated 140.3 m ha net cultivated area, 79.44 m ha (57%) is rain-fed[3], contributing 44% of the total foodgrain production. It is estimated that even after achieving the full irrigation potential, nearly 50% of the net cultivated area will remain dependent on rainfall. Rain-fed agriculture supports nearly 40% of India's estimated population of 1210 million in 2011. Cultivation of coarse cereals (91%), pulses (91%), oilseeds (80%) and cotton (65%) predominates in these rain-fed regions[4]. In the rain-fed areas, farmers' dependence on livestock, besides arable farming, as an alternative source of income is high. It is estimated that nearly two out of three heads of cattle population in India thrive in rain-fed regions. These data emphasize the crucial role played by rain-fed agriculture in India's food security. Yet the state of rain-fed agriculture is precarious and the problems associated with it are multifarious. To name the more striking ones: low cropping intensity, high cost of cultivation, poor adoption of modern technology, uncertainty in output, low productivity, increasing number of suicides among farmers, lack of institutional credit, inadequate public investment and high incidence of rural poverty[5].

Rain-fed production improvement through water management

During the recent years, while farmers in the high potential irrigated regions have increased crop yields by about 5% per annum, those in the rain-fed regions of India could increase agricultural production only less than 1% per annum. Foodgrain yields vary from 1 to 2 t ha^{-1} in the rain-fed regions compared to attainable yields of more than 4 t ha^{-1}. The large yield gap suggests that there is much to gain by improving productivity in rain-fed agriculture[6]. Water management could be a key strategy to unlock rain-fed production potential. On a regional basis, collecting small amounts of run-off using macro-catchments during the rainy season and utilizing this resource for supplementary irrigation can improve agricultural production in rain-fed areas[7].

A critical appraisal of the existing rainwater availability shows that India receives 4000 billion cubic metres (BCM) of rainwater annually and nearly 1600 BCM falls on agricultural land, about 240 BCM equivalent rainwater is available for harvesting in small-scale storages, regions with up to 1000 mm rainfall potentially produce 114 BCM run-off, and nearly one-fourth of annual rainfall is received before or after the cropping season[8]. Of 114 BCM available as surplus, about 28 BCM (19%) of water is needed for providing a single supplemental irrigation of 100 mm depth at the reproductive stage of rain-fed crops in an area of 27.5 m ha, thus leaving about 86 BCM (81%) to meet river/environmental flow and other requirements. Thus, rainwater capture and water resources management in the dominant rain-fed regions might not cause significant downstream impacts in India[9]. The spatial distribution of run-off by agro-ecological sub-regions and river basins is shown in Figure 1.

Our analysis has shown that with a single supplemental irrigation of 100 mm depth in a rain-fed area of 27.5 m ha, additional annual production enhancement of foodgrains of the order of about 9.3 mt could be achieved. Significant production improvements could also be realized in cotton, sesame, groundnut, soybean and chickpea.

The National Advisory Council of India (NAC)[10] estimated the total foodgrain requirements to be around 64 mt when the National Food Security Act will be fully rolled out. The additional annual foodgrain production of about 9 mt from the rain-fed areas with a supplemental irrigation using the harvested rainwater in combination with the current 54–59 mt annual procurement of rice and wheat will be able to meet the NAC estimates. Thus, the rain-fed agriculture could play a significant role in India's food security.

Water investments in rain-fed agriculture

Farmers mainly use refurbished natural depressions or dug-out ponds and check-dams for harvesting and storing surplus run-off. Based upon the national average cost of lined dug-out ponds and check-dams (Rs 18,500 ha^{-1}) and useful life of lined structures as 20 years, about Rs 51 billion will be required annually to provide a single supplemental irrigation to 27.5 m ha of rain-fed cultivated land and about half of that amount will be required for the production of foodgrains only. This amount works out to be Rs 2.7 billion for each additional million tonne

production of foodgrains. Compared to this, additional investment on irrigation infrastructure for each additional million tonne production of foodgrains increased from Rs 0.4 billion during 1970–1971 to Rs 62.4 billion in 2010–2011 in India.

Rain-fed agriculture will have to shoulder the largest burden of providing food in the developing countries. The knowledge already exists to at least double yields in rain-fed agriculture, even where water poses a particular challenge and large water investments focusing on water management are lacking.

The 2008 World Development Report emphasized that in order for agriculture to meet future food demand, water productivity improvements through water management and water uptake capacity of crops need to be achieved in the rain-fed areas. Estimates suggest that about 75% of the increased water requirement, needed to attain the 2015 hunger reduction target of the Millennium Development Goals set by the United Nations, has to come from water investments in rain-fed agriculture, as most hungry people live in these regions; there is a correlation between poverty, hunger and water stress. This calls for intensified efforts to upgrade rain-fed agriculture through balancing water for food and for ecosystem. Most of the new and innovative investment options are in this area.

There is a growing evidence on the importance of water investments in rain-fed agriculture and of the gradual redirection of policy, market strategies, governance, institutional support and management toward upgrading rain-fed agriculture as a key strategy for reducing poverty and increasing agricultural production. It is further becoming clear that water resources management for rain-fed agriculture requires a landscape perspective and involves cross-scale interactions from farm households to watersheds, to national and regional levels. Therefore, broader knowledge is needed for investments at national, regional, local and district levels[7].

Investments are required in local institutions for water management. Farmer organizations, small-scale credit schemes, private banking partnerships and other institutional arrangements need to go hand in hand with policy advances. Micro-credit schemes for water resources management investments are especially important. Rain-fed farmers generally cannot afford the large initial investments required even for small-scale water resources management systems, despite high benefit to cost ratio and the positive impact on long-term risk reduction. Improved water resources management needs to be supported by investments in infrastructure, transport, markets, communication, roads and land tenure.

Institutional reform is required at the national level to bridge the divide in governance of water resources. Relevant departments and ministries need to be more closely connected in legal, policy and management issues. Further, enabling environments are important. Finally, well-targeted economic support is essential in the context of the impending and inevitable climate change for sustainable rain-fed agriculture in India.

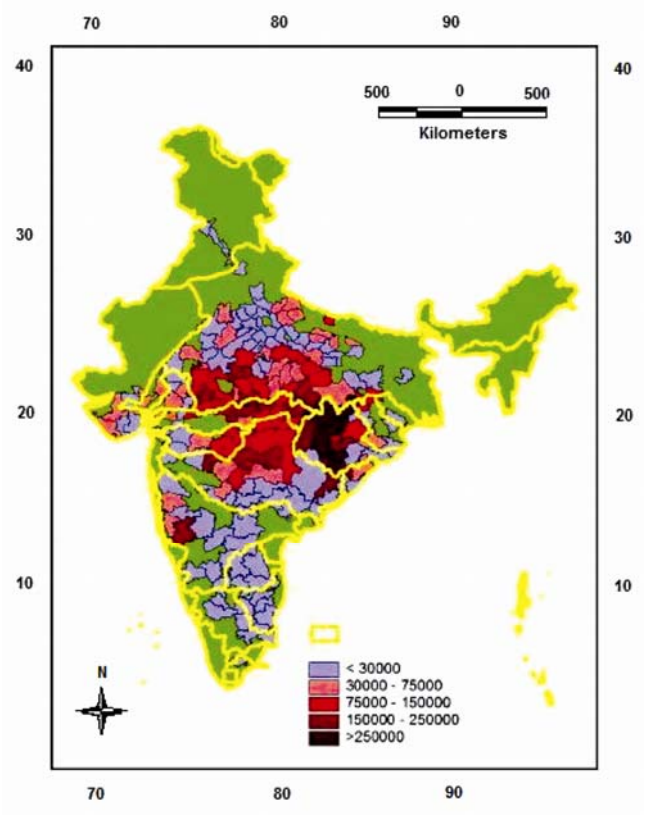

Figure 1. Spatial distribution of surplus run-off (mha) across dominant rain-fed districts and river basins of India (source: Sharma *et al.*[8]).

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