Climate ExChange

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Improved livelihoods and building resilience in the semi-arid tropics: science-led, knowledge-based watershed management

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Rainfed agriculture (1.25 billion hectares out of 1.55 billion hectares arable area) plays an important role globally in improving livelihoods and food security as it covers 63 per cent of total agriculture in Asia and 97 per cent in Africa. These areas are not only the hotspots of poverty but are also food insecure, hotspots of malnutrition, water scarcity, prone to severe land degradation and more vulnerable to the impacts of climate change.[1] With increasing demand for food production to meet the needs of the growing population (9 billion by 2050), growing incomes and changing food habits, water scarcity will also intensify. The per-capita availability of water has declined considerably; for example, in India water availability was 1,820 cubic metres per person in 2001 compared to 5,177 cubic metres in 1951, and it is expected to decrease further to 1,341 cubic metres by 2025 and 1140 cubic metres by 2050.

Water is a finite natural resource and agriculture is a major user, with 70 per cent of water withdrawal globally for food production. Green water (such as rainwater stored in the soil profile) is a valuable resource and often neglected when considering water management for food production, which constitutes 85 per cent of total freshwater use in crop plants and 98 per cent in grassland across the world.[2] With competing demand from other sectors like domestic, industry and ecosystem management, the pressure for efficient water use by agriculture will grow. Water is the primary limiting factor in dryland the water scarcity scenario in developing countries. Rainfed agriculture has a vast untapped potential, as the current farmers' yields are lower by two to five times that of achievable crop yields in Asia and Africa.[3]

Now, however, there is a new paradigm to unlock the potential of rainfed agriculture and build resilience against the impacts of climate change through knowledge-based interventions at watershed scale.

Impacts of climate change

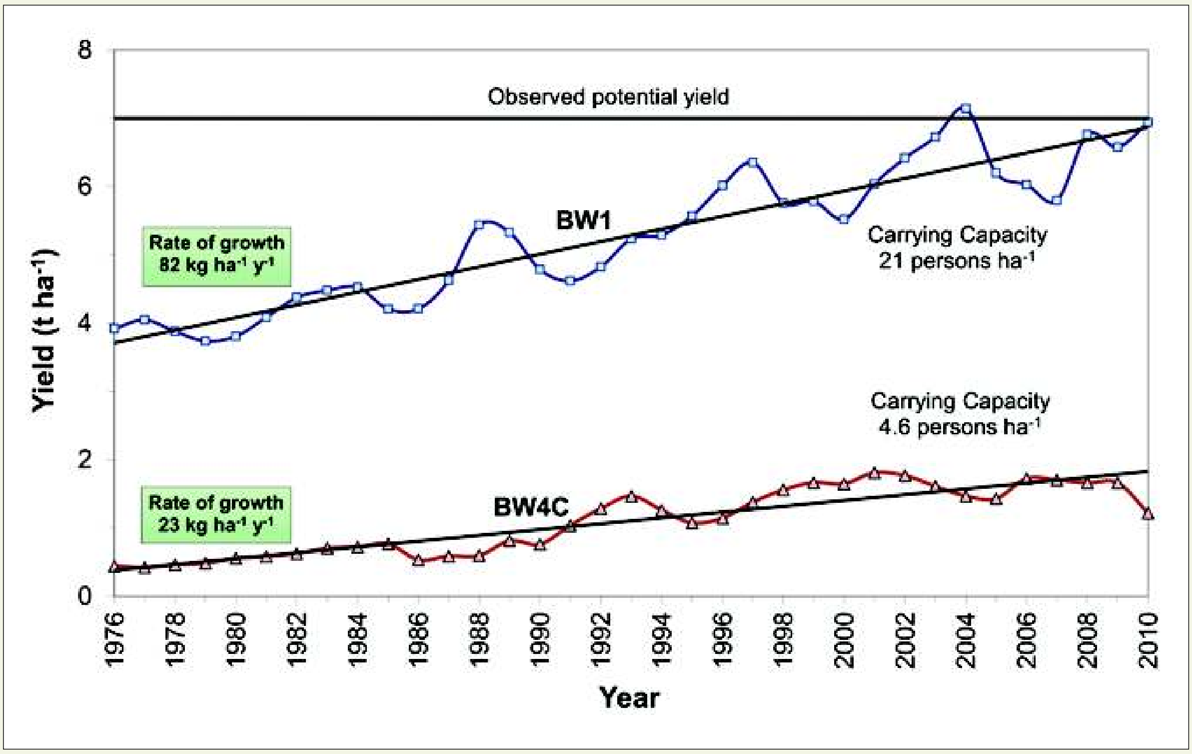
With the growing evidence of global warming and its associated impacts on climate change, the existing water scarcity scenario is getting further exacerbated by the increased variability of rainfall events during the season. Although impacts of climate change at macro level are established, a large knowledge gap exists at local level about the impacts of climate change. Further, millions of smallholders and development workers in Asia and Africa are not aware of the local impacts of climate change in their regions. For example, analysis at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has revealed that at Patancheru in India, a paradox of decreasing evapotranspiration under increasing temperature regime has been observed over the last 35 years, with a reduction of 200 mm y^{-1} in potential evapotranspiration from 1,850 mm to 1,650 mm largely due to decreasing wind speed.[4] Similarly, at Nemmikal watershed in the Nalgonda district of Andhra Pradesh, India, the length of the growing period (LGP) has decreased by about 15 days since 1978 and the climate has shifted to more aridity from semi-arid. The shift in LGP, if not understood by the farmers, generally results in more crop failures due to late season drought.

Another study using long-term gridded weather data sets in India revealed that 5.1 million hectares have become drier and 5.6 million hectares have become wetter during the periods 1971-1990 and 1991-2004. For example, Rajasthan (1.5 million hectares) and Gujarat (0.99 million hectares) became drier as some of the semi-arid tropic areas were converted into arid areas, with the largest shift in Madhya Pradesh where an additional 3.82 million hectares became semi-arid.

New paradigm

Considering the existing yield gaps and lack of knowledge for small and marginal farmers, ICRISAT and its partners have developed farmer-centric knowledge intensive soil, water, nutrient and crop management options at watershed scale through community participation.[5] Based on the participatory assessment of the constraints and potential as well as yield gap analysis using crop simulation models in consultation with community members, the potential interventions for rainwater harvesting, soil moisture conservation, soil fertility management, use of drought tolerant high-yielding cultivars, land and water management practices and integrated pest management options were introduced in partnership with the community.

Vast untapped potential of rainfed agriculture, (long term experiment at ICRISAT)



Source: ICRISAT

To provide the necessary knowledge to the farmers, an ICRISAT-led consortium comprising of national agricultural research systems, development agencies like government line departments and non-governmental organizations provided technical backstopping to the community. Soil health assessment, stress-tolerant high-yielding cultivars, water analysis and so on were used as an entry point for building rapport with the community. Improved rain-water management and harvesting resulted in ensuring increased green water use efficiency as well as augmenting water resources (ground and surface water) through low-cost water harvesting structures. Through watershed management, groundwater availability increased in benchmark watersheds in different states of India, Thailand, Vietnam and China.[6] The diagnostic participatory soil health assessment in the watershed revealed widespread deficiencies of zinc, boron and sulphur in farmers' fields which were holding back the potential of rainfed agriculture in the regions.[7]

Soil-test based plant nutrient management, along with seeds of improved cultivars, seed treatment and other soil and nutrient management practices, showed up to four-fold increases in crop yields at different benchmark watershed locations in India, Thailand, Vietnam and China. In addition, participatory watershed management reduced soil loss (by two to four times), increased groundwater recharge (2-3 m rise in the water table), reduced run-off (30-60 per cent), increased greenery cover and improved economic gains for the farmers. Social capital — in terms of collective action, institution building and self-help groups — provided add-on benefits from the integrated watershed management. These interventions at watershed scale have shown a win-win situation for upstream rainfed farmers with a positive trade-off in terms of a 30 per cent increase in incomes, with reduced run-off to the Osman sagar providing drinking water to Hyderabad, India with an additional cost of US$4 million.

These interventions improved green water use efficiency by 64-72 per cent, run-off reduced from 19 per cent to 8 per cent and enhanced groundwater recharge from 8 per cent to 20 per cent at the basin level. They also built resilience during the drought year, as evident from the data at Kothapally benchmark watershed. Here, in the 2002 drought year there was no change in the share of agricultural income to total family income in the watershed, whereas non-watershed villages saw a drastic reduction of agricultural income from 44 per cent to 12 per cent of family income. Families in non-watershed villages had to migrate for their livelihoods, whereas in Kothapally, farmers could manage their livelihoods.

ICRISAT and the Government of Karnataka have taken a knowledge-based, bridging yield gaps mission-mode initiative by forming a consortium and a network of stakeholders for sharing their knowledge about the weather as well as soil health and improved management practices covering all the 30 districts in the state. During the 2011 rainy season, the soil-test based nutrient management interventions along with improved seeds, seed treat-

Low-cost rainwater harvesting structures

ments and use of bio-fertilizers resulted in 21-66 per cent increases in crop yields covering three million hectares in 30 districts.

An innovative extension system was used as well as an institutional arrangement to empower the farmers through the Rytha Samparka Kendra (the state's extension service centre), farm facilitators and innovative supply chains. The missionary approach has shown its benefit for 3.3 million farmer families since 2009 through increases in productivity of 21-66 per cent over the farmers' practices. For the Government of Karnataka, this translated to an annual agricultural growth rate of 5.9 per cent during 2009-10, and 11.6 per cent growth during 2010-11. During 2011, three million hectares were covered in the rainy season and the economic returns were to the tune of US$ 130 million.

ICRISAT-led consortiums under the Andhra Pradesh Rural Livelihood Project of the Government of Andhra Pradesh and the Department for International Development have developed knowledge-sharing systems by developing a hub-and-spoke model at Addakal, one of the most drought-prone regions in Andhra Pradesh. The information and communication technology (ICT) based rural knowledge centre is operated by the women's self-help groups and is maintained not only as a knowledge-sharing system within the community, but also as a provider of financial services through cooperative banking and running a highway restaurant as to generate income. This ICT-based knowledge hub is under the Virtual Academy for the Semi-Arid Tropics and has been used further for providing ICT-enabled systems to enable early warnings for disaster management with a combination of top-down and bottom-up approaches and community mobilization.[8]

This pilot experiment revealed that the functional literacy of women was sufficient to handle ICT information hubs at watershed/village level and it enabled improved management of natural resources as well as improving their livelihoods by acting as a service provider to the community. The community actively participated in this initiative and has shown its potential for developing drought vulnerability assessments using ICT as a development tool with the help of intermediaries. The village knowledge centre is owned and operated by the community. Currently, the India Meteorological Department provides integrated advisory services for use by the farming community at district level. This network shares the information through email advisories, TV, mobile telephones and the radio network, and farmers are assisted with weather-based agro advisory through Krishi Vignan Kendras, enabling them to take advantage of prognosticated weather conditions and thereby form a response strategy.

There is an urgent need to develop a climate change network for Indian agriculture as well as for other countries in Asia and Africa by adopting a hybrid model of using ICT where it is feasible along with traditional communication channels like community radios, TV, mobile telephones and trained human resources at community and village level. This will go a long way in building the resilience of the community to cope with the impacts of climate change, particularly in rainfed areas of developing Asia and Africa. Such a knowledge network would enable the farmers to harness the untapped potential of rainfed agriculture for improving their livelihoods and achieving food security through sustainable intensification of rainfed agriculture.