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Reddy, A. Amarender

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A Amarender Reddy, ICAR-Indian Agricultural Research Institute, New Delhi

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The ongoing climate talks at COP 26 recognized the interlinkages between agriculture and climate change. Agriculture is extremely vulnerable to climate change. The climate change and higher temperatures eventually reduce yields of some crops while encouraging weed and pest proliferation(Reddy et al., 2021). The high frequency of droughts rises the likelihood of crop failures and loss of incomes from livestock. If timely action is not taken, the natural resource degradation further reduces crop yields in India, which are already low compared to global averages. For instance, the productivity of rice in India is just 40% of the global average.

Problems

The land and water resources are already overexploited in many parts of India. India's share in total land area of the World is just 2.4%, but it supports 18% of the World population. The average size of operational holding has declined from nearly 3.00 acre in 2010-11 to 2.08 acre in 2018-19. The latest NSS data shows that of the 9.3 crore agricultural households in India, 70.4 per cent holds less than 2.5 acre. The average monthly income of agricultural households is just 10,218 from all sources, with income from wages (4,063) is more than income from crop production(3,798) and income from livestock (1,582).

Opportunities

There is overwhelming evidence that if farmers follow integrated farming systems with a mixture crops and livestock along with the wider adaption of modern technology like precision farming, they can double their incomes and make farming climate resilient at the same time.

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In near future, India needs to increase its agricultural production at least by 30% not only to meet its growing domestic demand and exports and also to boost farmers' incomes and employment. Given the limited scope to increasing domestic demand, farmers have to focus on export-oriented crops like plantations, horticultural crops, commercial crops like cotton, chillies with precision farming technologies to meet export quality standards.

The predominantly irrigated areas and dryland areas are different in their agricultural practices and opportunities. For example, in general crops yields are more than twice in irrigated areas then drylands, hence, in this paper problems and opportunities of irrigated and drylands illustrated separately.

Irrigated lands

Successive governments built a large number of large to medium irrigation projects for irrigating the crops. However, since last 30 years, the importance of tube wells increased to tap the ground water with many states implementing free electricity for agriculture. Now irrigated area constitute about 40-50% of the cropped area (Reddy et al., 2017; Reddy et al., 2020). The rapid increase in tube wells even in water scarce zones resulted in expansion of area under water guzzling crops like paddy, wheat and sugarcane. This halted adaption of water saving technologies like drip and sprinkler systems and crop diversification towards less-water-intensive and higher-value crops like plantations, horticulture, cotton, oilseeds and pulses which fetch high incomes to farmers.

This resulted in lowering of water table in many states including Punjab, Haryana and Telangana. Nearly 80% of groundwater reservoirs in Punjab and 60% in Haryana are overexploited. Now it is time for wider adaption of technologies which maximize farmers income for each drop of water by using modern methods like precision farming. Now remote monitor and track systems are available to assess soil moisture levels and make timely irrigations decisions. This not only helps eliminate over or under watering but ultimately helps conserve water and maximize farmers' incomes.

Hence governments have to promote these technologies with subsidies and technological back up with private partnerships. The pricing of the natural resources like water also encourages farmers to adapt water saving technologies like drip and sprinkler which are about 70-80% more efficient than conventional irrigation and also increase yields by 30-40%.

Similar thing is happening in the case of fertilizer use, farmers are over using Urea, while underusing micro-nutrients, leading to imbalanced use of nutrients and less yields. Although use of fertilizers has contributed to boost agricultural productivity in the country, the imbalanced use of fertilizers not only reduce yields, they also pollute soil and water making them

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less sustainable for agricultural and human use. Farmers have to adapt fertilizers based on Soil Health Card recommendations for maximum crop yields.

Drylands

Still, Indian agriculture is monsoon dependent, especially dryland farmers who constitutes about 50 to 60% of the farming community (Peterson et al., 2006; Van et al., 2000). The dryland farming depends on monsoon rains from June to September, the rest of the year they have to depend on the moisture available in soils or use stored water from the farm ponds to grow crops in post-rainy season. In drylands, soil and water conservation technologies like farm ponds are crucial, with the adoption of these technologies, the possibility of growing two crops in a year will increase in addition to a substantial increase in grain yields.

With the increase in pressure on land with population increase, there is a significant increase in land degradation over the past years especially in drylands, if untreated land will not be suitable for cultivation in future. According to UNCCD, land degradation is the "reduction or loss of biological or economic productivity of the land due to climatic factors and also due to human intervention". Now, about 30% of geographical area in India classified as degraded land. Adaption of integrated farming systems (a systems approach in farming to maximization of yield of a mix of crops and livestock to provide steady and stable income at higher levels), investments in soil and water conservation technologies, incentives for adaption of these technologies are vital to reclaim these degraded lands and increase yields.

Drought proofing activities like tree plantation, forest restoration and growing of cover crops (cover crops are plants that are planted to cover the soil rather than for the purpose of being harvested to reduce soil erosion, weeds, pests, diseases and increase soil fertility) are equally important. Soil and water conservation technologies like construction of farm ponds (farm ponds are water storage structures, designed to collect excess runoff during rainy period, stored water can be used for supplemental irrigation to crops or to grow crops in post-rainy season), check dams (check dams are temporary structures designed across waterway to control storm-water runoff, prevent erosion), broad bed and furrow method of planting (it involves preparation of a broad bed of 90 cm, furrow of 45 cm with crops grown on broad bed, runoff water is diverted into field furrows to conserve water) are proven technologies to improve productivity of water and land resources, enhance soil corban sequestration, helps in reduction in surface run-off water and also soil erosion. Now, zero tillage (it is a method where the crop seed will be sown through drillers without prior land preparation and disturbing the soil) is popular among farmers in many parts of the drylands.

Now validated technologies are available to increase farm incomes in drylands, but their

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adoption process is complex when compared to simple to adopt technologies like high-yielding verities. These technologies need community approach involving various stakeholders like NGOs, agriculture and rural development. For example, most of the farm ponds, check dams are constructed under MGNREGA works, which needs active involvement of panchayat raj institutions.

The marginal and degraded lands are inhabited mostly by the poorest of the poor and used as grazing lands for animals. These technologies not only increase agricultural production, and also improve livelihoods options to these marginal people. However, these technologies will require social engineering and better watershed management initiative which are hard to achieve without community participation.

Conclusion

Overall, both irrigated and dryland agriculture needs substantial change in approaches for adoption of new technologies to achieve national commitment of doubling farmers income. In this climate resilient technologies play a crucial role to sustain gains, which are also in line with the India's international commitments like Land Degradation Neutrality (LDN) (it aims to balance loss due to land degradation with land restoration and sustainable land management) under the ongoing climate talks in COP-26.

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