Dryland Farming

Dryland farming is challenging with many constraints, but with the understanding of local climate and soil conditions, the selection of suitable crops, and the use of appropriate technologies, dryland farmers can produce bountiful crops even in the driest conditions. By adopting a suitable integrated farming model, dryland farmers can grow multiple crops in a single season with extra horticultural or livestock production.

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India is a land of great variability in climatic conditions and patterns due to its unique geographical location. Hence, characteristically different farming systems and cropping patterns evolved in different agro-climatic zones of the country. Dryland farming is one such practice which has assumed especial importance in view of the looming crisis of global warming and climate change. In recent years, dryland farming has emerged as a prominent path to ensure sustainable food security despite an increasing population and growing pressure on natural resources. Dryland farming refers to the cultivation of crops under natural rainfall conditions without or very scanty irrigation. Dryland areas are characterised by low rainfall within a range of 375 mm to 1125 mm, which are unevenly distributed, highly erratic, and uncertain. The dependency on rainfall makes these areas less productive and economically fragile, increasing their vulnerability to environmental stresses and shocks. These areas have generally poor or degraded soils with

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low water holding capacities and multiple nutrient deficiencies. The distribution of rainfall during the crop period is usually lopsided, with crops receiving a high amount of rain when it is not required and lack of it when they need it most. Dryland areas are often more prone to drought and drought-like conditions due to poor and weak structure of soil and depleting ground water tables. When monsoon sets in late, the sowing of crops is delayed resulting in poor yields. Similarly, when monsoon rains retract early, the crop is exposed to drought-like condition during critical stages of growth, which reduces crop yields. The soils of drylands are generally deficient in major nutrients such as nitrogen and phosphorus. Thus, in common parlance, drylands are not only thirsty but hungry as well! Huge variations in temperature not only affect crop growth and yields but also deteriorate quality of produce in most of the cases. In dryland areas, land holdings are generally small (less than two hectares), fragmented, and scattered, which makes farming less remunerative and difficult as well. Further, frequent crop failures coupled with a lack of market facilities and weak infrastructure ultimately lead to poor economic conditions of farmers. Agrarian distress is very common in dryland areas.

Distribution and Contributions

In India, terms like dry farming, dryland farming, and rainfed farming are often used interchangeably, but technically they are a bit different depending on the quantum of rainfall. Dry farming is practised in areas where the annual rainfall is less than 750 mm and the crop growing season is less than 200 days. It is generally practised in arid regions of the country. Cultivation receiving rainfall in the range of 750 mm to 1150 mm is known as 'dryland farming'. Crops in areas of semi-arid regions of the country are included under this category. Rainfed farming is a practice of crop cultivation without irrigation in areas receiving rainfall in the range of around 1150 mm. Most of its cultivation area falls in the humid and sub-humid regions of the country. In all these areas, irrigation facilities do not exist, and even protective or life saving irrigation is not possible. As per estimates, nearly 40 per cent of the net sown area in India will remain rainfed even after realising the full potential of irrigation. Of the 141 million hectares of estimated crop area in the country, close to 80 million hectares is under dryland farming, which is 52 per cent of the total cultivated land. Despite struggling with issues of scanty resources, environmental stress, and low productivity, the dryland agriculture is producing nearly 44 per cent of the total food grains in the country.

Geographically, dryland agriculture area in India includes the north western Rajasthan, the plateau region of central India, the alluvial plains of Ganga-Yamuna river basin, the central highlands of Gujarat, Maharashtra, and Madhya Pradesh, the shadow regions of Deccan in Maharashtra, the Deccan Plateau of Andhra Pradesh, and the Tamil Nadu highlands. However, the area under drylands is currently showing a declining trend and is expected to be stabilised by 2050 at around 75 million hectares. Globally, nearly 41 per cent of the earth's land surface is covered by drylands, of which 72 per cent are in the developing world and the rest, 28 per cent fall in developed / industrialised nations. Various definitions and criteria float around as estimates of the extent and intensity of rainfed areas in the country.

A recent report of the National Rainfed Area Authority (2020) identified and categorised 168 districts as 'very high' rainfed districts requiring interventions of drought-proofing on an urgent basis. Another 168 districts are categorised as high, 167 as medium, and 167 as low rainfed districts. In total, NRAA categorised 670 districts on an all India basis, of which 11 states have a high share of rainfed areas. These states are Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan, Tamil Nadu, and Uttar Pradesh. The estimates of rainfed areas vary significantly across the states. There are a few states which have a higher rainfed area as percentage of their net cropped area; so naturally, these are the states that suffer from vagaries of droughts with more than 20 per cent probability. There are 10 states that have more than 40 per cent of their net sown area under rainfed conditions. Among these, Assam comes under assured rainfall zone (2,579 mm per year), but has 87 per cent of its net sown area as rain dependent, and so is the case with Odisha. The rest of states have a large share of net sown area under rainfed conditions. States like Maharashtra, Karnataka, Andhra Pradesh, Gujarat, and Rajasthan are the most climatically vulnerable regions.

Despite various developmental efforts, agriculture remains the mainstay of the economy in dryland areas. Hence, the Government of India has launched many

schemes and programmes to increase per hectare productivity, production, and marketing facilities, along with the development of infrastructure. There is a vast scope to increase the productivity of dryland agriculture from the current average of 1.2 tonnes per hectare to 2.0 tonnes per hectare. According to experts, this potential can easily be achieved by inclusion of new technologies, diversification of crops, adoption of drought-tolerant varieties, and implementation of moisture retention techniques in the field.

Major dry farming crops include millets, now called nutri-cereals, oilseeds, pulses, maize, cereals, and cotton. Sorghum (Jowar), Pearl Millet (Bajra), and Finger Millet (Ragi) are most commonly grown millets in drylands, while other millet species are also cultivated across rainfed areas. Almost 80 per cent of Sorghum and Maize, 90 per cent of Pearl millet, 75 per cent of oilseeds, and approximately 95 per cent of pulses are obtained from dryland agriculture. Contributions to wheat and rice production are also important, because 33 per cent of wheat and 66 per cent of rice are still rainfed. Apart from contributing to food security, drylands also give a boost to the textile sector by contributing more than 70 per cent cotton to industries. Millets are traditional and staple crops of dryland, and they are the most popular due to their specific attributes which suit these regions. Millets, now also called *Shri Anna* are annual, short-duration (75 to 120 days) rainfed crops that grow well on shallow, low-fertility soils. Millets have a very low water requirement and can be grown even under extremely high temperatures and low rainfall. These crops are resistant to drought, resistant to most pests and diseases, and need minimum care. In nutshell, millets are eco-friendly and climate resilient crops. In the continuing 'International year of Millets', the Government of India is promoting and supporting production, processing, marketing, and export of millets and millet products, which will further help expansion of millets in rainfed regions. Marginal lands in rainfed regions offer potential for fodder production to feed the cattle population, which is an integral component of the farming ecosystem in arid regions.

Oilseeds are major crops in rainfed regions, grown mainly with low levels of input usage. Oilseed crops are mostly cultivated on marginal lands by resource-poor small farmers in biotically stressed conditions. This results in low productivity, poor quality and lower profit margins to farmers. To improve the condition, the latest production technologies and drought-tolerant varieties were introduced in drylands under a special programme on mustard and rapeseed during Rabi season. Consequently, India has registered a compound annual growth rate of 7.7 per cent in vegetable oil production from 2015-16 to 2020-21. The improvement in production of oilseeds in rainfed regions will save valuable foreign exchange reserves, as India is still importing oilseeds to meet domestic demand. The dryland pulses help the small holder farmers in arid and semi-arid regions withstand weather variability. Pulses are also called climate smart crops because they require less water' survive weather fluctuations, improve soil health and provide more nutrition per drop. Pulses in rainfed regions are ideal for on-farm diversification. As an intercrop with cereals and other crops, pulses bring in extra income for farmers and at the same time increase the yield of the main crop. To enhance the production and productivity of cotton in rainfed regions, several improved varieties have been developed exclusively for drylands, along with their own customised production technologies.

The introduction of crop diversification and integrated farming systems in dryland regions has brought many changes in terms of area and yield. The area which was initially under Pearl Millet and Sorghum was replaced by more remunerative crops. A shift of pulse growing area from one agro-climatic zone to another was recorded due to many climatic and socio-economic factors. The area under Cotton and Maize increased drastically, mainly due to the increased irrigation facilities provided for these crops.

Strategies and Schemes

Dryland farming is characterised by long spells of drought, high temperatures, and other climatic adversities which can lead to partial or complete crop failure. To mitigate the risk of crop failure, scientists have developed various techniques, which are being extended and demonstrated to farmers for quick adoption. Agronomic approaches have been developed basically to conserve soil and water, in

order to achieve maximum productivity. Selection of proper cropping system suitable to the area is one of the key strategies in drylands, which becomes more remunerative with proper management of sowing time. Similarly, proper tillage, fertiliser management, proper weed control, and adoption of plant protection measures also contribute towards enhancing productivity. The selection of drought-tolerant or resistant varieties is another key technique as these varieties can withstand long periods of drought better than other varieties. Improvement of soil condition can be achieved by planting cover crops which are known to slow erosion, improve soil health, enhance water availability, help control pests and diseases, and bring a host of other benefits as well. Cover crops are plants that are planted to cover the soil rather than for the purpose of being harvested. There are evidences that growing cover crops increases resilience in the face of drought conditions and erratic rainfall.

Mulching is a common dryland technique to conserve moisture in the soil by preventing evaporation. Mulch is a material, generally straw, leaves, or plastic, that is spread over the soil's surface to prevent its natural exposure to sunlight. Mulch also helps to keep the roots of plants cooler, which can help them survive during periods of drought. Shelterbelts and windbreaks are other common water conservation techniques prevalent in dryland farming. These are rows of trees and shrubs planted on the ridge or around the field to provide wind. They not only help reduce evaporation but also protect crops from damage by strong winds. Weed control is an important strategy in dryland farming because, if left unchecked, weeds can compete with crops for water. Crop rotation in the field on a yearly basis helps prevent soil depletion and maintain fertility. Deep tillage and contour ploughing allow water to penetrate deeper into the ground. Some engineering approaches, such as contouring and compartmental bunding, preserve moisture and prevent soil erosion in dryland areas. Check dams and farm ponds are common water harvesting structures in rainfed regions that help provide life-saving irrigation during long dry spells.

The success story of appropriate strategies, technologies, and innovations dates back to 1950s when the Government of India realised the significant role of dryland agriculture in Indian food production system; and decided to improve stability and productivity of drylands through R&D efforts. Various R&D centres at different dryland locations initiated work for developing appropriate soil and water conservation practices. Later, in 1970, the Indian Council of Agricultural Research (ICAR) launched the All India Coordinated Research Project for Dryland Agriculture (AICRPDA) at Hyderabad, with 23 cooperating centres spread across the country. It marked the beginning of an era of location specific adaptive research in dryland agriculture. To further strengthen basic and adaptive research, ICAR established Central Research Institute for Dryland Agriculture (CRIDA) at Hyderabad in 1985. Since then, India has not looked back. Over the years, CRIDA has played a pioneering role in developing and disseminating improved rainfed farming technologies in different agro ecological regions of the county. Large number of technologies in rainwater management, watershed development, soil health management, cropping systems, etc., have been implemented in fields with impressive success rates. However, increasing climatic variability and climate change posed new challenges to dryland agriculture, which necessitated the development of adaptation and mitigation strategies. The ICAR launched a flagship network project called the National Innovations in Climate Resilient Agriculture (NICRA), primarily to develop and promote climate-resilient technologies in agriculture with a special focus on rainfed regions. The project also aims to address vulnerable areas of the country and help districts and regions prone to extreme weather conditions, most notably droughts, high temperatures, and heat waves. The NICRA project has developed several climate-resilient technologies which include climate resilient varieties of different crops, resilient intercropping systems, crop diversification with alternate crops, agro forestry systems, in-situ moisture conservation, farm pond, integrated framing systems, etc. Such technologies have been developed and popularised for wider adoption in various fields. Agricultural contingency plans for 650 districts have been made available online for policy makers to take decisions in the event of delayed monsoons and other extreme weather events. Climate resilient technologies are being demonstrated on farmers' fields in 151 clusters covering 446 villages.

The Government of India is implementing a scheme on rainfed area development under the National Mission for Sustainable Agriculture. The scheme focuses on integrated farming systems for enhancing productivity and minimising risks associated with climatic variability. Under this system, crops / cropping systems are integrated with activities such as horticulture, livestock, fishery, agro-forestry, apiculture, etc. The scheme aims to cover an area of 6.74 lakh hectare with appropriate and location-specific Integrated Farming Systems. Schemes such as Per Drop More Crop, Soil Health Card and the Paramparagat Krishi Vikas Yojana are also contributing in the improvement of dryland agriculture through their own components.

Way Forward

CRIDA has developed 'The Vision 2050', which outlines the future scenario, new and emerging challenges, the strength of the existing network, and strategies to meet short and long term goals. Location-specific research and its efficient delivery will be guiding principles to bring sustainability to the dryland agriculture system. The primary focus may be laid on rainwater harvesting and soil health management through intensive efforts and scaling up successful field experiences. Integrated farming modules for different production environments must be attempted on a priority basis for the risk-proofing of small and marginal farmers. As per the vision, cutting edge technologies such as remote sensing and GIS (Geographic Information System) applications will be exploited for natural resource characterisation and land-use planning. Nanotechnology based products and processes will also be developed for application in dryland agriculture. Several research strategies for improving resource efficiency in rainfed areas will be demonstrated on a large scale. Small farm mechanisation is another important area in this regard that needs early attention and addressal due to uneven monsoon patterns, drudgery, and an acute shortage of labour for agricultural operations. Energy efficiency and management, in conjunction with precision agriculture, need to be implemented in dryland areas for better productivity and profitability. In this regard, the use of solar power and other renewable sources needs to be promoted in dryland regions.

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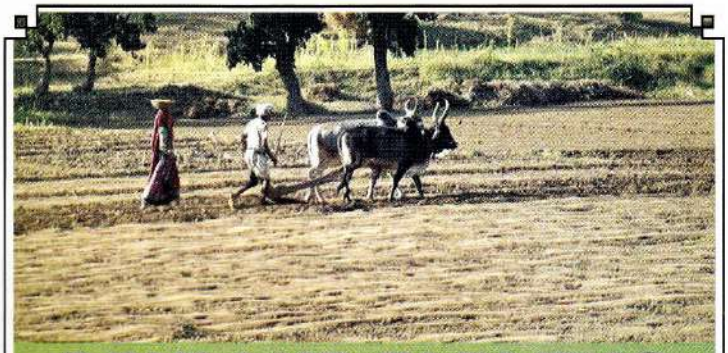

DRYLAND FARMING

In a larger perspective, dryland farming helps conserve water resources, minimises soil erosion and promotes sustainable agriculture. Technologies for dryland farming can help mitigate the adverse impacts of climate change by reducing greenhouse gas emissions and promoting soil carbon sequestration.

Dryland farming helps increase the amount of organic matter in the soil, improving its fertility, and structure. By providing due attention and importance to dryland areas, the concerns and issues in production of pulses and oilseeds can be effectively addressed.

The dryland areas have tremendous potential for increasing food production which, if realised, would boost the agriculture dependent economy of the country. It will also help address the problem of hunger and malnutrition prevailing in disadvantaged and resource poor sections of society.