

Resource conservation technologies in rainfed areas of Central India

S R K Singh*, Anupam Mishra and Varsha Shrivatava

ICAR-ATARI, Zone-IX, Jabalpur, Madhya Pradesh 482 004

Green revolution era witnessed overexploitation of natural resources like soil and water, and income from rainfed agriculture system is declining in many areas as cultivation costs are rising. The article describes various resource conservation technologies (RCT) like rainwater harvesting, in-situ moisture conservation, zero tillage, micro-irrigation, direct seeding of rice with seed-cum-fertilizer drill, organic fertilizers, crop diversification and afforestation which can save soil, water and other natural resources. As the machinery required for adoption of these resource conserving technologies are heavy and costly, these machines should be used on custom hiring basis or groups' ownership.

Keywords: *In-situ* moisture conservation, Rainfed agriculture, Rain water harvesting, Resource conservation technologies, Soil conservation, Water conservation, Zero tillage

RAINFED agriculture (crop and animal husbandry) is now emerging as a major opportunity in raising overall agricultural growth. Rainfed agriculture supports nearly 40% of India's population. India ranks first among the rainfed countries in the world in terms of rainfed area, but ranks among the lowest in rainfed yields (<1 t/ha). In present situation, country will have to feed about 1.3 billion people requiring 5-6 mt of additional food grains every year. Besides this, the problem of poverty and malnutrition has their own implication to national food security.

The rainfed lands suffer from a number of biophysical and socio-economic constraints, which affect productivity of crops and livestock. These include low and erratic rainfall, land degradation and poor productivity, low level of input use and technology adoption, low draft power availability, inadequate fodder availability, low productive livestock and resource poor farmers and inadequate credit availability. Total 73% area in Central India is rainfed.

Soil and water are major natural resources for all living beings. Not

only increasing world population but also misuse of the soil and water resources are exerting pressure on these resources. It is necessary to conserve these resources to feed the growing population. We should keep natural resources safely for future generation and sustainable production. Degradation in soil and water has adverse impact on agricultural productivity, due to population increase, soil erosion, deforestation, low vegetative cover and unbalanced crop and livestock production. To overcome these issues, it is imperative to adopt various resource conserving technologies to improve agriculture productivity and sustain farmer's income. Rainfed agriculture, therefore, is quite capable with an appreciable potential for meeting the increasing food requirements of rising population of the country.

Characteristics of rainfed farming

Rainfall (mm): >750

Moisture: Enough/sufficient

Growing regions: Humid and Sub humid regions

Cropping system: Intercropping or

double cropping

Constraints: Water erosion

Constraints associated with rainfed farming are moisture stress and uncertain rainfall; selection or limited crops; utilization of preserved moisture; quality of the produce; storage of rain water; soil crusting and compaction; nutrient depletion, low fertilizer use efficiency and imbalanced fertilizer use. Key elements to prevent risk of rainfed agriculture are capturing and conservation of moisture; effective use of available moisture; soil conservation and control of input costs.

RESOURCE CONSERVATION TECHNOLOGIES

Conserving rainwater through water harvesting techniques

Rainwater harvesting technology is collecting and concentrating various forms of run-off from precipitation and for various purposes. The concept behind collection of water is that the share of land precipitation is collected which is nonproductive and small and bring

this amount closer to crop water requirements for economical agricultural production. There are various methods available to collect rainwater harvest.

Percolation tank: Percolation tank is an artificial reservoir constructed across stream, submerging a land area with adequate permeability to facilitate sufficient percolation to collect surface water run-off and allow it to percolate within the permeable land. This is one of the effective methods of refilling groundwater table. The capacity of strata in the tank bed governs the ideal size of the percolation tank. The storage capacity of percolation tank varies from 0.1-0.5 MCM and a ponded water column should be generally between 3 and 4.5 m.

Farm pond: A farm pond is a large hole dug out in the earth, usually square or rectangular in shape, which harvests rainwater and stores it for future use. The ideal farm pond should be dug into the ground in a naturally low-lying area and corner of the plot of land. Soil removed during excavation can be used to construct an earthen bund around the pond,



which should be planted with trees and grasses for stability. The shade and wind protection provided by the raised mound and vegetation will reduce evaporative losses. A pond that is about 10 m × 10 m and 3 m deep is an ideal size. The pond should have an inlet and an outlet (as shown in the picture) lined with rock to prevent erosion.

In-situ moisture conservation techniques

To increase the moisture availability to the agricultural crops, it is necessary to adopt *in-situ* moisture conservation techniques in addition to the large-scale soil and

moisture conservation and water harvesting structures in the watershed. The principle behind the recommendation of different practices is to increase the infiltration by reducing the rate of runoff, temporarily impounding the water on the surface of the soil to increase the opportunity time for infiltration and modifying the land configuration for inter plot water harvesting.

Broad bed furrow: Due to extreme rainfall events, the crop gets affected either due to dry spells or due to water logging owing to lack of proper drainage that hampered the plant growth. Water logging occurs mostly in black soils. There is a need for *in-situ* soil and water conservation and proper drainage technology in deep black soils. Broad bed and furrow (BBF) system involves preparation of a broad bed of 90 cm, furrow of 45 cm and sowing of crop at a row spacing of 30 cm. The BBF technology has many advantages



including *in-situ* conservation of rainwater in furrows, better drainage of excess water and proper aeration in the seedbed and root zone. This method mostly used in soybean crop. The maximum seed yield of soybean was recorded when grown on broad bed furrow system of planting as compared to conventional method of sowing i.e. flat bed sowing.

Raised bed planting: Raised bed alters the crop geometry and land configuration. It offers more effective control over irrigation and drainage as well as has impact on transport and transformations of nutrients, and rainwater management during the monsoon.

FIRB: Furrow-irrigated raised bed technology is one of the efficient irrigation methods in which water moves in furrow, and crop is planted



on raised beds. The sowing on raised beds is done with the help of the raised bed planter. The machine has adjustable blades for making raised beds of different widths and heights that can be adjusted by the shifting of blades on the frame and roller on the rear. It has seed-cum-fertilizer drilling mechanism for sowing one, two or three rows on each bed. The planter makes two beds at a time. The width



of beds can also be adjusted from 65-70 cm. The planter is fitted with knife type tines so that it can also be used for sowing of other crops. The benefits of the machine are saving of cost of operation, seed (25%) fertilizer (25%), irrigation water (35%).

This system of raised bed planting of crops is advantageous in areas where groundwater levels are falling and herbicide -resistant weeds are becoming a problem. This system also facilitates crop diversification and intercropping of wheat, chickpea and Indian mustard with sugarcane, maize with potato, mint with wheat, rice with soybean and pigeon pea with sorghum or green gram.

Ridge and furrow: The method is generally adopted in areas with moderate rainfall having drainage problem. Deep furrows are opened in 'v' shape 10-15 cm deep or 20 cm.

Deep ploughing: Tillage operations done during summer. The primary objective of opening of the soil crust accompanied by deep ploughing and simultaneously overturning of the

soil underneath to disinfect it with the help of piercing sun rays. This is done mostly as preparatory tillage for main season crop to destroy weeds, soil borne insect pests and pathogens, receive and retain rain water and to check water erosion. Summer tillage is suitable for alluvial, red and other light soils. At best two summer ploughings are done prior to advent of monsoon at an interval of 15-20 days. Third ploughing can be done once with the help of harrow or cultivator to pulverize the soil and prepare field beds for sowing/transplanting soon after the first monsoon rain.

Compartment bund: Compartmental bunding means the entire field is divided into small compartments with pre determined size to retain the rain water where it falls and arrest soil erosion. The compartmental bunds are formed using bund former. The size of the



bunds depends upon slope of the land. This is suitable for lesser rainfall area and <1% slop. The lands are divided into small compartments with the dimension of 8 × 5 m². Compartmental bunds provide more opportunity time for water to infiltrate into the soil and help in conserving soil moisture.

Laser land leveling

Laser land leveling is a simple operation that is performed before sowing to prepare land. A laser land leveller is used for land levelling. It is machine equipped with a laser guided drag bucket. It is much more effective and take less time in making flat table top like surface. Flat surface ensures distribution of irrigation water in every parts of the field and

minimal waste from runoff or water logging with lowering irrigation time. Laser land leveling is climate resilient practice that not only saves scarce resources like water and energy but also increases yield, income and environment friendly practice.

Micro-irrigation

Micro-irrigation is the slow application of water as discrete or continuous drips, tiny streams or miniature spray on, above, or below the soil by surface drip, subsurface drip, bubbler and micro-sprinkler systems. It is applied through emitters connected to a water delivery line through low-pressure delivery. Micro-irrigation has become a policy priority in India. The new catch phrase in one of the central government's schemes, *Pradhan Mantri Krishi Sinchai Yojana* (PMKSY or Prime Minister's Agriculture Irrigation Programme), is



'Per Drop More Crop'. This system is also used for fertigation that reduces the loss of nutrients and directly provide nutrients into root zone of crops thus appropriate amount of fertilizer reached to crop and used efficiently.

Conservation agriculture

Conservation agriculture (CA) is defined as a sustainable agriculture production system comprising a set of farming practices adapted to the requirements of crops and local conditions of each region, whose farming and soil management techniques protect the soil from erosion and degradation, improve its quality and biodiversity, and contribute to the preservation of the natural resources, water and air, while optimizing yields. Conservation

tillage includes minimum tillage, no till or zero till, direct drill, mulch tillage, stubble mulch and strip tillage for reducing infiltration and reducing run off. Thus, it helps reducing soil erosion. Conservation agriculture mainly working on three principles minimum soil disturbance, maintenance of permanent soil cover and, cropping system delivery and crop rotation.

Zero tillage: This concept is related to conservation agriculture. Zero tillage is the process where the crop seed is sown through drillers without prior land preparation and disturbing the soil where previous crop stubbles are present. Zero tillage not only reduce the cost of cultivation but also reduces the soil erosion, crop duration and irrigation requirement and weed effect which is better than tillage. Zero Tillage (ZT) is also called No Tillage or Nil Tillage.



Zero tillage proves better for direct-seeded rice, maize, soybean, cotton, pigeonpea, mungbean, clusterbean, pearl millet during *kharif* and wheat, barley, chickpea, mustard and lentil during *rabi*. Wheat sowing after rice can be advanced by 10-12 days by adopting this technique compared to conventionally tilled wheat, and wheat yield reduction caused by late sowing can be avoided. ZT provides opportunity to escape wheat crop from terminal heat stress.



It also reduces *Phalaris* minor problem in wheat. Zero tillage reduces water requirement of crop and the loss of organic carbon by oxidation.

Direct seed sowing

Direct seeding of rice is not a new idea. A number of farmers were growing this for decades. In this technique, seed is directly seeded and field remains dry most of the season. Direct seed sowing can be performed in two conditions first one is dry direct seeding and another is wet direct seeding. In both the conditions farmers can sow seeds by broadcasting and drilling method. In dry seeding method, seeds are sown by drilling into a fine seedbed and fertilizer can be applied at the same time as the seed. Wet seeding requires leveled fields to be harrowed and then flooded (puddling). The field is left for 12-24 hours after puddling, then germinated seeds (48-72 hours) are sown using a drum seeder. Direct seed sowing overcomes the problem of seasonality in labour requirement for rice nursery raising and transplanting operations. It saves water by 35-40%, reduces production cost and increases yields.

Use of organic and farm waste

In soil and water conservation measures, adoption of organic farming is a key component of rainfed farming. Organic and farm waste can increase farm productivity and repair decades of environmental damage. Good amount of organic matter increases the water holding

capacity of soil. Mulching or mulch-cum-manuring, residue management, green leaf manuring, cover cropping are other strategies that conserve moisture and improve nutrient use efficiency in rainfed areas. The use of FYM or other organic nutrient sources during aberrant rainfall years in particular have an additional advantage of protecting the crop from drought besides the nutritional benefits. Biomass production during the off-season (without competition with the *kharif* crop) through a legume cover cropping and its incorporation in the soil can be another strategy to overcome the limitation of organic matter availability.

Crop diversification

Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a particular farm taking into account the different returns from value added crops with complementary marketing opportunities. The aim of crop diversification is to increase crop portfolio so that farmers are not dependent on a single crop to generate their income. Introducing a greater range of varieties in a particular agro - ecosystem leads to diversification of agricultural production, which can also increase natural biodiversity, strengthening the ability of the agro-ecosystem to respond to these stresses. Crop diversification and growing of large number of crops are practised in dryland areas to reduce the risk factor of crop failures due to recurring

droughts.

Afforestation

Afforestation is the establishment of a forest or stand of trees in an area where there was no previous tree cover. Afforestation is highly important to maintain biodiversity and ecological balances. It is also important to prevent global warming, soil erosion and pollution. Afforestation purifies the environment and helps in reducing the carbon dioxide level.

SUMMARY

The increasing demand for basic food in the future will be met by increased productivity and it can be obtained only by the judicious use of natural resources. The RCTs provide a platform for this. Change in tillage as well as land and water management practice conserves soil, water and other natural resources. The tillage and stubble management will improve soil structure and also soil nutrient status, ultimately maintains soil ecosystem. RCT contributes in management of insect pest and weed, conserve beneficial microorganisms and improves organic matter in the soil. These practices are environmentally safe and reduce greenhouse effects due to carbon sequestration. It sustains agriculture production and income of the farmers in rainfed areas of Central India.

*Corresponding author e-mail: singhsrk@yahoo.co.in

Model farm machinery package for different agro-climatic zones of India

As per National Agricultural Research Project, the country has 127 agro-climatic zones. Every zone is suitable for a certain range of crops and cultivars, which requires suitable machinery. To create awareness and make better use of available machinery, a model farm machinery package for different agro-climatic zones of India was developed, and is available as web based and mobile app. The developed model farm machinery package is able to provide details of state wise, agro-climatic zone wise, district wise, cropping pattern wise and power source wise model machinery package. It also includes economic parameters such as machine cost, per hour operating cost, hiring rate, the total annual cost and net return, break-even analysis, payback period, machine specifications and available manufacturers for different agro-climatic zones of India. The developed package is very useful in calculating various technical and economic parameters leading to decision making for establishment of technically feasible and economically viable model farm machinery for custom hiring at various agro-climatic zones/districts in India.

Source: DARE-ICAR Annual Report 2019-20