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RCT's: An adaptable approach for conservation of agricultural resources under climate changing scenario

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Introduction

Agricultural productivity depend on natural resources of a region which includes land (over 55% of non-forest land), water (about 80% of total freshwater), soil, biodiversity (forests, pastures and wildlife) and climate. Increasing population and increase in their standard of living are placing tremendous pressure on the natural resources. Furthermore, the increase in productivity is at the expense of deterioration in the natural resource base. The impact of the resource degradation is more on rainfed regions. Globally 80% of the cultivated area is rainfed and produces 62% of the staple food. Farmer's yields in rainfed regions in the developing countries are low and unstable due to climate change and resource degradation due to over-exploitation of natural resources. Furthermore, the productivity of rainfed crops depends upon the quantity, distribution of rainfall and duration of intermittent dry spells experienced during different growth stages of the crop. Hence, the primary way to unlock the potential of rainfed agriculture in dry areas is by optimal resource conservation technologies without adverse environmental impact is need of the hour. The resource conservation technologies (RCTs) are the practices that enhance resource or input-use efficiency like increasing the nutrient and rain water use efficiency by improving the water conservation to overcome drought spells.

The major rainfed crops are groundnut, red gram, maize, ragi, bajra, castor, cotton etc. Recent experiences in India indicated that participatory demonstration of resource conservation technologies can help farmers to cope with current climate variability, enhance resource or input-use efficiency which primarily focus on resource conservation and have long-term benefits which in turn help in development of sustainable livelihoods. The first predominant cause for degradation of productive capacity of soils is water and wind erosion and this is more pronounced in rainfed regions. The rainfed soils have high slope which varies from 1 to 10% with low infiltration capacity, added to this high intense rains in this regions is a common phenomenon which causes runoff and loss of top layer of fertile soils along with the nutrients, and results in shallow depth of soils and poor ground water. The amount of agricultural land going out of production each year due to soil erosion is about 20 million hectares, and approximately 40% of the world's cropland is now degraded hence natural resource conservation is the basic thing for sustainable agricultural production, the natural resources should be conserved effectively to meet the needs of the future generations. The erosion increases further due to faulty agricultural practices. According to estimation, globally 60-70 of soil is eroded ha^{-1} every year. Further it is 2-3 t/ha and >10 t/ha of fertile soil is eroded in medium soils and steep sloped soils respectively. On an average, in a year of the total eroded soil, 61, 10 and 29% is deposited elsewhere, reservoirs and into oceans respectively.

Several RCT were identified by the researchers worldwide which include ex-situ and in-situ water conservation, adoption of appropriate land use based cropping systems, balance nutrient application/site specific nutrient management, organic nutrient management and conservation agriculture with three principles like minimum tillage, residue cover and crop diversification. These technologies aims at improving agro ecosystem productivity, biodiversity conservation, reduce land degradation, improve rain water use efficiency, ensure the sustainability of forests and manage the sustainability of wildlife, fisheries, and furthermore these technologies in a way help in adaptation and mitigation of the effects of global climate change.

In-situ rainwater conservation includes deep tillage, land configuration methods like broad bed, conservation furrows, contour farming, graded border strips, mulching which can be made with low cost and energy efficient implements are some of the efficient methods which hold great promise. However, the *in-situ* conservation methods adopted are based on rainfall, soil type, topography, climate and cropping system (Table 1) and land capability classification.

Studies by CRIDA at Hyderabad, Bangalore and Anantapur revealed that more than 80% farmers follow *in-situ* conservation measures like sowing across the slope, opening of dead

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furrows and key line cultivation since *in-situ* conservation methods are comparatively easier to be adopted by farmers than *ex-situ* rainwater conservation. This in-situ rainwater conservation in rainfed areas is a way to bridge gap between potential productivity of available crop varieties and existing crop yields by improving soil moisture content and reducing soil erosion (Pathak *et al.*, 2009).

Table 1: Soil and water conservation measures for various rainfall zones

Rainfall			
<500mm	**500-750mm**	**750-1000mm**	**>1000mm**
1. *In-situ* conservation in between rows 2. Contour cultivation 3. Dead furrows 4. Field bunds 5. Tie bunds 6. Mulching 7. Ploughing across the slope	1. Contour cultivation 2. Live bunds 3. Field bunds 4. *In-situ* conservation in between rows 5. Tie bunds 6. Mulching 7. Dead furrows 8. Vertical mulching in black soils.	1. Vertical mulching in black soils. 2. Contour cultivation 3. Dead furrows Live bunds 4. Minimum tillage 5. Graded bunds 6. Cultivation of crops across the slope.	1. Live bunds 2. Field bunds 3. Graded bunds 4. Vertical mulching in black soils.

Conservation agriculture (CA) is an important environment friendly strategy and addresses the resource degradation by arresting and reversing the downward spiral of resource degradation and efficient use of natural resources. The studies conducted in rainfed regions with various cropping systems at CRIDA has shown that the CA records lower yields in the initial years but may over take conventional tillage subsequently. The added advantage of CA is reduction of soil erosion, improved organic carbon and soil fertility due to addition of crop residues and crop rotation furthermore the reduction in fossil fuel use under no till agriculture results in reduction of GHGs emissions and CA helps in mitigation of climate change by reducing GHGs emission and increasing carbon sequestration. But the key to success of CA is retention of crop residues on the soil and the weed control. The major constraints to adopt CA in rainfed regions is

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availability of crop residues as the livestock compete for fodder, termite infestation to the residues in rainfed regions is more, weed control and seeding of crops in zero tillage. Studies at CRIDA has shown that the crop residues can be increased by manipulation of harvesting height of the crop, growing of cover crops between widely spaced crops, cultivation of second crop like horse gram after harvest of short duration crop. The crops like pigeon pea, castor can be harvested upto 30 cm ht whereas cereal crops like maize and jowar should be harvested at 60 cm ht since the fodder quality and nutrients are better in maize and jowar in the top portions of the crop. So harvesting at 60 cm has dual advantage. The harvested above portion is used as fodder and the lower part can be used as crop residues to the soil. It was observed that termite infestation will be more on the crop residues present on the soil surface than the anchored crop residues.

Soil Amendments

Besides the biological agronomic and engineering measures application of the soil amendments like tank silt in red and sandy shallow soils to improve water holding capacity and application of sand to black soils, organic residues help not only to improve soil texture and structure but reduces the erosion and conserves soil moisture. The silt deposited in the lakes and tanks of villages which is rich in nutrients and organic carbon content can be used. Red and sandy soils are predominant in dry land are sand soils have low clay content, due to the low clay content, percolation of rainwater is more. Hence, to increase the water holding capacity of these soils, tank silt can be added to the top layers of soil, through which water is stored by reducing deep percolation. Application of silt besides increasing water holding capacity is also a good source of nutrients. Moreover, desilting of tanks improves moisture availability and storage capacity of tanks. Tank silt application reduces soil erosion and prevents the loss of nutrients from soil. Studies at CRIDA have shown that application tank silt increases 10-20% of yield along with 30-40% of increased soil moisture. The quantity of tank silt to be applied to soil depends on clay content of soil. Tank silt can be applied once in every three years. This will help in proper mixing up of silt to the soil whenever rains occur. The major precaution to be taken is to avoid high pH tank silt. The added advantage of tank silt application is desilting of tanks improves storage capacity of tanks. And these tank beds can be used to grow fodder in summer season. Studies at CRIDA have shown that tank silt application improved the crop yields by 10-

20% along with 30-40% of increased soil moisture. The quantity of tank silt to be applied to soil depends on clay content of soil. Tank silt can be applied once in every three years. This will help in proper mixing up of silt to the soil whenever rains occur. The major precaution to be taken is to avoid high pH tank silt.