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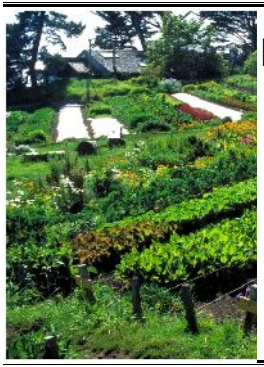

Resource conservation technology for sustainable food production

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Green revolution has changed the scenario of Indian agriculture from food scarcity towards food security. As per recent statistics our food gain production has reached to 252.67 MT (Directorate of Economics and Statistics, 2014-15), but the productivity of the major staple food crops *viz.*, Rice and wheat remained low. Rice and wheat are major staple food crops of large masses which decide the picture of food sufficiency at national as well as at global level. But due to impact of green revolution and ill effects of global warming, the productivity of these two crops has declined at alarming rate especially in Indo-Gangetic plains. It is due to overexploitation of natural resources particularly water, excessive use of chemical fertilizers and pesticides leads to deterioration of physical condition of soil. These result into yield stagnation causing concern about the future potential for productivity and sustainability. Thus the major challenges before us to innovate appropriate technologies to produce more food from diminished land and water resources for the burgeoning population pressure and to improve as well as conserve natural resources wisely.

Resources conserving technologies (RCTs) conserve the resources and produce more output with less input. It aims at reversing the process of degradation inherent to the conventional agricultural practices like intensive cultivation, burning or removal of crop residues, aggressive seed bed preparation with heavy machineries lead to declining the fertility, biodiversity and erosion Resource conservation technogies (RCTs) aim to utilize all the natural resources wisely to sustain the production and maintain ecological balance which is key for successful sustainable agriculture production. There are different challenges in crop production like declining ground water table, deterioration in soil fertility and soil physical environment, high energy requirements and increasing air and ground water pollution, so there is need to proper utilizes resources and conserve them by use of RCTs practices like Zero tillage, Minimum tillage Crop residues management, Laser land leveling, SRI in rice, FIRBs, Use of leaf color chart for nitrogen management. RCTs produce more output with less use of input/resources.

Need of resource conservation technology (RCT): Resource conservation technology (RCT) refers to any management approach or technology that increases factor productivity including land, labour, capital and inputs. The agricultural resources domain covers capital, land, labour, machinery and agricultural inputs such as fertilizers and pesticides etc. Resources conservation technologies (RCTs) conserve the resources and produce more output with less input. RCT consists two terms resource and conservation. Resource is any physical or virtual entity of limited availability that needs to be consumed to obtain a benefit from it. In most cases, commercial or even non-commercial factor require resource allocation through resource management. Whereas, conservation means management of the human use natural resources to provide the maximum benefit to current generation while maintaining capacity to meet the needs of future generations.

Cereals are highly-nutrient exhaustive crops. Their intensive cultivation has resulted in deterioration of overall soil health, including the nutrient and moisture holding capacity of the soil. The farmers have left age-old, traditional and time-tested practices, such as use of organic manures, green manuring, intercropping with legumes, systematic crop rotations, mulching etc. due to various reasons. The deterioration in soil fertility has forced the farmers to use more and more chemical fertilizers per unit area to realize higher productivity of crops. During the green revolution era main focus was on enhancing the productivity of selected food grains which poised major resource degradation problems we are facing today are declining factor productivity,declining ground water table, development of salinity hazards, deterioration in soil

fertility,deterioration in soil physical environment,biotic interferences and declining biodiversity,reduced availability of protective food and increasing air and ground water pollution.Therefore, in the post-green revolution era the issues of conservation have assumed greater importance in view of widespread resource degradation problems and to need to reduce production costs, increase profitability and make agriculture more competitive.

Resource conservation technologies in crop production :

Minimum tillage/Zero tillage/Rotary tillage : Minimum tillage-The concept of minimum tillage was started in USA in 1974. Minimum tillage is aimed at reducing tillage to the minimum necessary for ensuring a good seedbed, rapid germination, a satisfactory stand and favorable growing condition. Tillage can be reduced in two ways: by omitting operations which do not give much benefit when compared to the cost and by combining agricultural operations like seeding and fertilizer application.

Zero tillage : Zero tillage is an extreme form of minimum tillage in which primary tillage is completely avoided and secondary tillage is restricted to seedbed preparation in the row zone only. It helps in early sowing, saves water, labor and diesel, increases fertilizer use efficiency, reduces soil erosion improve soil organic carbon and increases crop yield upto 20% .

Rotary tillage : Rotary tillage is the best option for increasing productivity and net returns, followed by zero tillage and conventional drill sowing (Chauhan, 2003). Rotary tillage technology is a tractor-driven version of the rotavator attached to power tiller, which pulverizes the soil, places the seed and fertilizer at appropriate depth and does in a single operation.

Fig. 1 : Zero tillage practice

Fig. 2 : Crop germination in zero tillage practice

Crop residue management/ Mulching : Turbo seeder is an advance version of happy seeder developed by PAU. The Happy Seeder is a tractor-powered machine that cuts and lifts the rice straw, sows into the bare soil, and deposits the straw over the sown area as a mulch. The Happy Seeder thus combines stubble mulching and seed and fertiliser drilling into a single passage. It has got positive influences on soil organic carbon, N, P and K. It also increases aerobic bacteria (5-10 times) and fungi population in soil, it reduces bulk density and maintains soil temperature. Incorporation of crop residues alter the soil environment, which in turn influences microbial population, there activity in the soil and subsequent nutrient transformation. It is through chain of events of crop residues management, regulates the efficiency with which fertilizer, water and other reserves are used in a cropping system (Singh *et al*., 2005).

Brown manuring : Brown manuring is a technique to grow Sesbania crop in standing rice crop and kill them with the help of herbicide for manuring. After killing the colour of the Sesbania residue becomes brown so it called brown manuring. This technique is useful in many ways. It exerts smothering effect on weed spp., helps in conserving moisture, adds organic matter in soil and fixes atmospheric nitrogen in soil.

Laser land leveling : Land leveling through laser leveler is one such proven technology that is highly useful in conservation of irrigation water. Laser leveling results in a much more level field. Laser land leveling is leveling the field within certain degree of desired slope using a guided laser beam throughout the field. Laser land leveling technology is advantageous in many ways. It saves 35-45 % water due to uniform leveling of land lead to better

distribution of water on entire field. It also saves about 15-25% fertilizers. It also increases the farming area which was previously unutilized. Due to uniform leveling good healthy crop stand is maintained there by crop productivity also improved.

Fig. 3 : Laser land leveling : A precursor technology for resource conservation

Surface seeding : Excess soil moisture lead delayed sowings after rice harvest in lowland areas. Seeds of wheat broadcast (about a week before harvesting) or on wet/ muddy soil (after rice harvest).It is suitable for areas where land preparation is very difficult and costly, and often results in cloddy tilth. Heavy textured soils are more suitable for surface seeding and special equipment not needed.

Aerobic rice production : Aerobic rice is a production system in which especially developed aerobic rice varieties are grown in well drained, non puddle and non saturated soil with appropriate management.

Rice is direct seeded on dry bed and irrigation is applied at an interval to maintain optimum soil moisture in the field. It saves 40-50% water and 80- 85% lesser methane emission.

Direct seeded rice (DSR) : Rice is sown directly in dry seeding or wet seeding, and irrigation is given to keep the soil sufficiently moist for good plant growth, but the soil is never flooded. This technology has proved more viable due to its number of benefits. It is labour, fuel, time and water saving (75%) technology and gives higher net economic returns. It does not require to prepare nursery, to care for it and pulling of seedlings etc. The direct-seeded plants mature 7 to 10 days earlier than transplanted rice thus reduce the duration of crop. They are not subjected to stress like being pulled from the soil of the nursery.

System of rice intensification (SRI) : It was developed in 1983 by the Henri de Laulanie in Madagascar. System of Rice Intensification (SRI) is a methodology aimed at increasing the yield of rice produced in farming. It is a low water, labor-intensive, organic method that uses younger seedlings singly spaced and typically hand weeded with special tools. The SRI principles consist early, quick and healthy plant establishment. In this system low plant population of rice crop is maintained. Watering is controlled and given in less quantity. Emphasis is given to enrich the soil through addition of organic matter in soil.

System of wheat intensification (SWI) : In the prevalent system of wheat cultivation requires more chemical fertilizers and nearly 100-120 kg of seed per hectare. SWI uses only 20-30 kg of improved seed in one hectare. Twenty to twenty five cm spacing between rows, use of manure and organic seed treatment ensures higher yield. Sufficient spacing between the plants and sowing of two seed grains at one point facilitates desired moisture, aeration, nutrition and light to the crop roots, this helps faster growth of plants. Only 2-3 times irrigation and weeding through cono-weeder save time and expenses on labor.

Furrow irrigated raised bed system (FIRBs) : In this method, wheat is sown on raised beds in 2-3 rows. Planting on this type of bed reduces the population of *Phalaris minor* on the top of the bed also reduces the lodging of wheat crop. This system reduce the seed and nutrient requirement by 25%. Wheat crop can be conveniently irrigated by this method and saves about 30-40% water requirement.Excess water could also be easily drained.

Use of leaf color chart : A simple handy, ever-lasting

Fig. 4 : Furrow irrigated raised bed system in wheat

pocket tool made up high quality plastic material and consists of six strips of different shades from pale green to dark green color. It is easy to use and inexpensive, an alternative to chlorophyll meter. It measures leaf color intensity which is related to nitrogen status of leaf. This is very useful to the farmers to determine the right time of nitrogen application to crops.

Fertilizer use efficiency : The yield of crops (biomass or economic yield) in kg of nutrient applied is called as fertilizer use efficiency. Crop must be sown timely, ideal plant population maintained, and on that population basis the fertilizer should be applied. Judicious use of organic manures, bio-fertilizers and chemical fertilizers can increase the fertilizer use efficiency. Inclusion of legume crop in crop rotation and inter cropping system will add atmospheric nitrogen in soil and reduce the cost on chemical nitrogenous fertilizers. For cereal crops particularly rice and wheat full dose of P and K should be applied as basal and N should be applied in 2-3 splits as basal and top dress for better use efficiency. It can also be improved by management practices like application of fertilizer at right time, right rate and at right place. Micro irrigation system also increase the fertilizer use efficiency by preventing the loss of nutrients by leaching.

Drip irrigation : Drip irrigation was discovered in Israel, discharge rate of water per unit area is 1-4 lit/hr. It saves about 60-70 % water and even more. Herbigation and fertigation is possible through drip irrigation. Deep percolation, surface runoff, evaporations losses are minimum. No land leveling is required therefore saves labor cost on leveling and preparation of irrigation channels. Since watering is done under control there are less chances of disease and weed infestation in the field.

Conclusion : The present day agriculture is capital, energy and labor intensive and thereby warrant special emphasis on the efficient use of natural resources. The

present food grain production is 252.6 MT which is not sufficient to feed the existing population of 1.2 billion. The food requirement during 2020 is estimated as 300 MT so the conservation of natural and agricultural resources is necessary. Thus combine use of these Resource Conservation Technologies together will help to augment the agriculture productivity and maintain the health of the soil and ecological balance in sustainable manner.

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