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Review On: Resource conservation practices for sustainable agriculture

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Abstract
Conservation agriculture useful for meeting future food demands and also contributing to sustainable agriculture. It helps to minimizing the negative environmental effect and equally important to increase income of farmer by reducing cost of cultivation. Introduction of conservation technologies (CT) was an important break through for sustaining productivity. It seeks to conserve, improve and make more efficient use of natural resources through integrated management of soil, water, crops and other biological resources in combination with selected external inputs. The term Conservation agriculture refers to the system of raising crops without tilling the soil while retaining crop residues on the soil surface. The total area under no-tillage/zero tillage in India it is about 3.43 m ha. Efforts to adapt and promote resource conservation technologies have been underway for nearly a decade.Spread of conservation agriculture have been made through the combined efforts of several SAU's, ICAR institutes and the CG promoted, Rice-Wheat Consortium for the Indo-Gangetic Plains. Resource conservation technologies should form an important component of the regional strategy for food security, rural development, enhance profitability, and sustainability of natural resources. Resource conservation practices saved on fuel, labour, irrigation water, production cost, energy etc along with positive effects on soil health and environmental quality. Thus conservation agriculture that help farmer to reduce cost of cultivation and increase their profitability & improving soil health should be encouraged for their large scale acceleration at farm level.

Keywords: Conservation Agriculture**,** Tillage practices, Crop residue management.

Introduction
The term 'Conservation Agriculture' refers to the system of raising crops without tilling the soil while retaining crop residues on the soil surface. CA is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. CA is based on enhancing natural biological processes above and below the ground. Farmers concerned about the environmental sustainability of their crop production systems combined with ever-increasing production costs have begun to adopt and adapt improved systems management practices that lead towards the ultimate vision of sustainable conservation agriculture solutions. Conservation agriculture systems utilize soils for the production of crops with the aim of reducing excessive mixing of the soil and maintaining crop residues on the soil surface in order to minimize damage to the environment. The name conservation agriculture has been used to distinguish this more sustainable agriculture from the narrowly defined "conservation tillage" (Wall, 2006) [10]. Conservation tillage is a widely used term to characterize the development of new crop production technologies that are normally associated with some degree of tillage reductions, for both pre-plant as well as in-season mechanical weed control operations that may result in some level of crop residue retention on the soil surface. The definition of conservation tillage does not specify any particular optimum level of tillage, but it does stipulate that the residue coverage on the soil surface should be at least 30% (Jarecki and Lal, 2003) [4].

Need for conservation agriculture
- Conventional "arable" agriculture is normally based on soil tillage as the main operation.
- The soils degrade under prolonged intensive arable agriculture.
- This structural degradation of the soils results in the formation of crusts and compaction and leads in the end to soil erosion.
- Soil erosion resulting from soil tillage has forced us to look for alternatives and to reverse the process of soil degradation.
- Soil degradation due to non judicious use of agricultural inputs and over exploitation of

- natural resources has emerged as great threat to sustain crop productivity and soil quality.
- The most important soil degradation processes are decline in nutrient supplying capacity, fertility depletion and loss of soil organic carbon.

Resource conservation practices

Integrated nutrient management (INM), Tillage, Crop residue, Mulching, Biofertilizer, Crop rotation, Green manuring

1) INM

Integrated Nutrient Management is the maintenance of soil fertility and a plant nutrient supply to an optimum level for sustaining desired crop productivity through optimization of benefits from all possible sources of plant nutrients in an integrated manner. It is the combined application of chemical fertilizers along with organic resource materials like, organic manures, green manures, bi-fertilizers and other organic decomposable materials for crop production. IPNS is ecologically, socially and economically viable and environment friendly which can be practiced by farmers to derive higher productivity with simultaneously maintaining soil fertility. Integrated nutrient management encourages the use of on-farm organics, thus it saves on the cost of fertilizers for crop production. The concept includes key areas like, maintenance/adjustment of soil fertility, optimum plant nutrient supply, sustaining desired level of productivity, optimization of benefits from all possible sources of nutrients and addressing environmental concerns. This may be achieved through combined use of all possible sources of nutrients and their scientific management for optimum growth, yield and quality of different crops and cropping systems. The interactive advantages of combining organic and inorganic sources of nutrients in INM have proved superior to the sole use of these sources (Ray *et al*., 1991).

The advantages of INM can be broadly enumerated as restoration and sustenance of soil fertility and crop productivity, prevention of secondary and micronutrient deficiencies, economizing in fertiliser use and improvement in nutrient use efficiency and favourable effect on the physical, chemical and biological health of soils (Singh *et al.*, 2012) [7]. Enhances the availability of applied as well as native soil nutrients, Synchronizes the nutrient demand of the crop with nutrient supply from native and applied sources. Provides balanced nutrition to crops and minimizes the antagonistic effects resulting from hidden deficiencies and nutrient imbalance.

2) Tillage

Tillage is referred to as mechanical manipulation of soil using implement by loosening it for good germination of seeds, plant growth and help soil water conservation. Tillage is the manipulation of soil with the help of implements to obtain a desired seed bed. It is one of the most important component of conservation agriculture. It is labor-intensive activity in low resource agriculture of small land holders, It is capital and energy intensive activity in large scale mechanized farming. Judiciously used tillage can be useful asset in compaction, crusting, reduced infiltration, accelerated run off and erosion, and degradation of soil and environment.

The main functions of soil tillage:

- To produce optimal conditions for seed germination and emergence
- To increase water infiltration and aeration
- To eliminate the competition with weeds
- To bury or incorporate organic material, crop residues and or manure aims to create a soil environment favourable to plant growth.
- Increase moisture storage capacity of soil profile management of crop residues, provide weed control, increase soil aeration improve temperature, facilitate seed germination and increase yield.It facilitates provide in situ moisture conservation, incorporation of manures, fertilizers, soil amendment into soil,

Effects of Tillage

1) Positive effects

- Ploughing loosens and aerates the top layer of soil which can facilitate the planting of the crop.
- It helps in the mixing of residue from the harvest, organic matter (humus) and nutrients evenly throughout the soil.
- It is used for destroying weeds.

2) Negative effects of ploughing

- Dries the soil before seeding.
- The soil loses a lot of its nutrients like carbon, nitrogn and its ability to store water.
- Erosion of soil.
- Decreases the water infiltration rate of soil.
- Reduces organic matter in the soil (Microbes, carbon compounds, earthworms, ants, etc.)
- Destroys soil aggregates.
- Eutrophication
- Can attract some harmful insects to the field.

3) Crop Residues

Crop residues are incorporated in soil before sowing of crop or succeeding crop. Period available for decomposition of crop residues is important so as to insure availability of nutrients. Crop residues having wide C:N ratio decomposes slowly in the soil. Decomposition is highly influenced by soil properties, temperature and moisture regime. Crop residue is the largest agricultural harvest. Over half of all dry matter in the global harvest consists of cereal and legume straws; tops, stalks, leaves, and shoots of tuber, oil, sugar, and vegetable crops; and pruning and litter from fruit and nut trees (Smil, 1999) [9]. The emergence of crop residue as a valuable resource has evolved to the point where there are competing uses for it. Crop residue, in general, are parts of plants left in the field after crops have been harvested and threshed or left after pastures are grazed. These materials have at times been regarded as waste materials that require disposal but it has become increasingly realized that they are important natural resources and not wastes (Kumar *et al.* 2002) [5]. Environment that in turn influences the microbial population and activity in the soil and subsequent nutrient transformations. Incorporation of cereal straws of wide C: N ratio, however, is reported to immobilize soil N and adversely affects the yield of the succeeding crop (Sindu *et al.* 1989) [6]. Crop residue amendment can increase the biomass yield and SOC content, and the increase in SOC improves soil fertility. Thus, the practice of crop residue amendment forms a positive relation between SOC content and biomass yield (Zhang, 2006) [11]

Effect of crop residues on physical properties of soil

- Soil structure: Favor the formation of aggregates
- Bulk Density & porosity: Decreases the bulk density of

soil & increase the porosity of the soils.
- Hydraulic conductivity: Increase hydraulic conductivity by modifying soil structure microspores.
- Soil temperature: Increases the minimum soil temperature in winter and decrease soil temperature during summer due to shading effect.
- Soil moisture: Reduces evaporation rate due to increase in amount of residues on the soil surface.

Effect of crop residues recycling on chemical properties of soil:
- Organic carbon: Increases with continuous O.M. addition
- Soil pH: Increases soil pH significantly. By decarboxylation of organic anions & addition of basic cations.
- C.E.C.: Soil O.M. as reservoir for plant nutrients, Addition of residues increase C.E.C.

Effect of crop residues recycling on biological properties of soil
- It provides energy for growth & activities of microbes and substrates for microbial Biomass.
- Provide suitable environment for Biological N – fixation.
- Enzymes (dehydrogenase and alkaline phosphatase) activities increase in soil.
- Increase in microbial population.
- Humus formation.

4) Mulching

Crop residues as a surface mulch

Mulch influences reflectivity of heat and water transmission characteristics of mulched soil. Mulch also improves the soil water storage and reduces evaporation losses. Mulch helps in on moisture conservation and minimize soil temperature. Crop residue is an effective mean of runoff, erosion and transport of sediment to stream. (Bairathi., 1974) [3] The beneficial effects of returning crop residue as mulch on crop yield are well known. These benefits are due not only to the recycling of plant nutrients but also to improvements in soil moisture and temperature regimes, enhancement of soil structure, and erosion control. However, the use of crop residues as fertilizers is especially important to resource-poor farmers. Many materials are used as mulches, which are used to retain soil moisture, regulate soil temperature, suppress weed growth, and for aesthetics().The practice of burning crop residue directly in the field then developed, because crop residue had come to be considered a waste product and this burning became a regional environmental problem. Later, with the promotion of sustainable development in agriculture, wheat residue amendment combined with mechanisation was encouraged by the government and this crop residues use as surface mulch.

5) Crop Rotation

Crop rotation is the practice of growing a series of dissimilar or different types of crops in the same area in sequenced seasons. It is done so that the soil of farms is not used for only one set of nutrients. It helps in reducing soil erosion and increases soil fertility and crop yield. Crop rotation helps to maintain soil structure and nutrient levels and to prevent soilborne pests from getting a foothold in the garden. When a single crop is planted in the same place every year, the soil structure slowly deteriorates as the same nutrients are used time and time again. After a few years, the soil becomes unhealthy, drained of those specific nutrients. Simultaneously, insect pests that feed on the single crop—and that spend their larval stage in the soil—become more prolific as their food source remains. These pests become harder to manage every year as their population increases. Crop rotations profoundly modify the soil environment. The sequence of crops in rotation not only influences the removal of nutrients from a soil, but also the return of crop residues, the development and distribution of biopores and the dynamics of microbial communities. (Ball *et al.* 2005) [2]

The effects of crop rotation
- Higher diversity in plant production and thus in human and livestock nutrition.
- Reduction and reduced risk of pest and weed infestations. Greater distribution of channels or biopores created by diverse roots (various forms, sizes and depths).
- Better distribution of water and nutrients through the soil profile.
- Exploration for nutrients and water of diverse strata of the soil profile by roots of many different plant species resulting in a greater use of the available nutrients and water.
- Increased nitrogen fixation through certain plant-soil biota symbionts and improved balance of N/P/K from both organic and mineral sources.
- Increased humus formation

6) Green mannuring

Green manuring is the practice of growing lush plants on the site into which you want to incorporate organic matter, then turning into the soil while it is still fresh. The plant material used in this way is called a green manure. Green manure/cover crops are plants that are grown in order to provide soil cover and to improve the physical, chemical, and biological characteristics of soil. GMCCs may be sown independently or in association with crops. Provide soil cover for No-Tillage (reduces water and soil temperature, and increases water infiltration). Protect soil from erosion. Reduce weed infestation. Add biomass to soil (in order to accumulate soil organic matter, add and recycle nutrients, feed soil life). Improve soil structure. Promote biological soil preparation and reduce pest and disease infestation (Donald, 2010) [3]. Cover and Green Manure Crops as a conservation practice can improve soil health. Soil quality benefits such as increased organic matter, biological activity, aggregate stability, infiltration, and nutrient cycling accrue much faster under no-till than other tillage practices that partially incorporate the residue. One example comes from the Jim Kinsella farming operation near Lexington, Illinois. He reports that organic matter levels have increased from 1.9 percent 6.2 percent after 19 years of continuous no-till (Schertz and Kemper, 1994) [8].

Conclusion

CA practices result in resource improvement only gradually and benefit in terms of crop yields may not come out immediately, evaluation and impact of CA practices therefore needs a longer term and a broader perspective which goes beyond yield increases only. Integration of tillage practices and management of balance nutrients through organic and inorganic sources helps to sustain the soil quality (Physical, Chemical and Biological properties) and productivity of crops. Adoption of efficient tillage practices is essential for sustenance of soil health in long run. Caution must be taken to avoid blanket adoption of CA just everywhere; it should be site-specific and need based.

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