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Conservation agriculture impacts on soil environment, crop rotations, weeds and residue management- A review

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Abstract

In Pakistan major cost of production is intensive tillage result in wasting resources, disturbing soil physical properties through clean cultivation worsening the situation. To decrease cost of production, it is the need of time to search alternative crop production systems. Conservation agriculture (CA) is an emerging technology, which serves as an alternate system has been successfully adopted worldwide for sustainable agriculture, to improve soil properties, mitigate climate change, enhance crop yield and reduce input cost. Conservation agriculture, including continuous soil cover, minimal soil disturbance, diverse crop rotations and integrated weed management. Conservation agriculture includes the zero tillage technology, laser land leveling and many other included in it. In the field of sowing, developed models of seed drill was manufactured and tested in the field demonstration to check ability of its working and to compare the yield. The machine is the zero seed drill and the zero till ferti drill is being used for wheat sowing. New resource conservation technologies for sowing as Happy Seeder and Zone Disk Tiller Machines works on the principle of zero tillage. Promotion of CA can be enhanced by encouraging local manufacture of zero tillage drills and on farm trainings of the community. CA is the need of hour to combat desertification and provide a healthy environment for coming generations and resource poor farmers of Pakistan.

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Introduction

The farming industry of Pakistan plays an important economic role, contributing 18.9% to GDP and absorbing 42.3% of the workforce. It is also a major source of foreign currency income and boosts development in other industries. The state concentrates its activities on helping small and marginalized farmers to support the development of small-scale, innovative techniques. Pakistan's population is increasing at a pace of 2.4 percent per year, as per the 6th Pakistani Population and Housing Census 2017. This rapid population increase raises the demand for farm products. In this respect, the current government has taken steps to develop this industry, for instance crop diversification, the effective use of water and promoting high-value plants including biotechnology, lowering mark-up rates, improving agricultural loans, subsidized fertilizer prices, and inexpensive electricity for agro-tube wells. The sector's output therefore improved considerably in the last 13 years following a mild and modest development. (Statistics of Pakistan).

Ghosh *et al* (2011) tried over five years (2006-10) in the mid-altitudes of Meghalai to monitor the effectiveness of resource-conserving techniques such as zero tillage, minimum operation, management of residue, green manure, manure of leaves and implementation of weed biomass in rice and rice cropping systems. Results showed that zero and minimum tillage save human power, decreases the cost of manufacturing at least' 2000-3000 ha-1.

Grover and Tarun (2011) examined the impact of zero tillage technology in rice- wheat system in Punjab. Two districts viz. Patiala and Sangrur were selected for the study. The results showed that total cost of cultivation was `14881 and `17500 on the zero till farms and conventional farms respectively. The yield recorded was larger on zero tilled farms (52.18q ha-1 valued at `32876 than conventional method (50.55q ha-1, valued at `31826). Study asserted that the adoption of zero tillage technology improved farmer's profit, livelihood and eventually reduce poverty. Mehta and Singh (2005) conducted study on some RCT's like zero-tillage sowing of wheat, bed planting, paddy straw management and use of Leaf Colour Chart for nitrogen management in paddy in Punjab with the help of various KVKs. Results showed that the zero-till-seed-cum-fertilizer drill sowing of wheat gave a weighted average increase in yield of 6.4 percent in Haryana and 2.6 percent in Punjab over conventional method of sowing. Further the study claimed that it reduced the phalaris minor (a menacing weed of wheat) population by 30 percent and cost of tillage operations from `2,000 to 500 ha^{-1}.

Paul *et al* (2005) assessed by examining some study outcomes globally that advantages of conservation farming as a retarded land degradation. Different sources of evidence indicate that demographic pressure and unsustainable land use in many locations of the developing globe have resulted in serious soil deterioration and food insecurity. Therefore, conservation agriculture based primarily on three principles, minimum soil disturbance, continuous soil protection and adequate plant rotation has become an interesting intervention as it has been shown in over 95 million ha globally to be economically lucrative, environmental safer, and practically effective. In participatory development modes for farm innovation the development and fine tuning of CA-techniques for the various production technologies in the region has a substantive effect and accelerated the implementation of these CA-based RCTs. Participating studies have shown that CA methods have been producing equal or greater productivity, savings in irrigation water utilization, enhanced farm profitability, decreased GWP, adaptive to the effect of climate change and enhanced soil health in the intensive agro-ecosystem environment for long-term sustainable agriculture compared with standard, intensive labouring methods. Furthermore, the study suggested that the entire CA should be produced and implemented at the farm level to obtain future benefits, with all primary parts from the system point of perspective. The long-term impact of CA on agriculture, soil and biodiversity and the environment in the various production technologies and agro ecologies should be part of a future research agenda in the framework of natural resource management programs.

Animals were the basis for agriculture and in the CA residue preservation of plants was needed, and research into environmental preservation systems for long-term technological sustainability should therefore be launched.

Ramakrishna *et al.* (2005) stated that it was time to raise consciousness of the significance of soil resources, soil organic matter. The focus of studies was therefore needed to enhance the effectiveness of fertilizer use and to reduce pesticide use. The integrated nutrient management and integrated pest management strategy could strengthen this aspect. This could be reinforced. Consequently, appropriate sowing time, suitable seed rate, seed depth and soil contact, row orientation, etc. are the significant elements requiring study focus. Appropriate cultivars with input responsiveness were also significant elements in conservation agriculture. he development of adequate instruments for zero tillage seeding, the inclusion of residues and intercultural activities requires interdisciplinary study work. In addition, study focusing on the modeling of tillage dynamics and root development, the integration of soil physical characteristics into crop simulation models and its association with crop yields in large crop sequences was required.

Jat *et al.,* 2009 evaluated that in the Indo-Gangetically Plastic Plains (IGP) in South Asia, development and good tuning of CA methods for distinct manufacturing processes. Resources of participatory research show that CA technologies have led to equivalent or greater productivity, savings in water irrigation, enhanced agricultural rendering, decreased GWP, adaptable to the impacts of climate change and better soil health in intensive agro-ecosystems for long-term, viable agriculture relative to standard intensive farming methods. The entire CA with all important components in the system's view is, nevertheless, to be developed and implemented at farm level in order to achieve future advantages. Study suggested that the future agenda for studies under the natural resource management program should include the long-term impacts of CA on crops, soils, biodiversity and the climate in various production and agro-ecological systems.

There is an immediate need for the identification of viable property management approaches to suit food production to the growing global population. However, the fight for food security should take into account the soil in which plants are cultivated and the environment in which living beings survive. Conservation agriculture is advocating large-scale information globally, practicing agriculture in a manner that can result in minimal environmental harm. The main element of CA is conservation tillage, soil health and plant development, as well as the environment, is considered. The purpose of this article is a review of the job carried out on conservation laying in various agro-ecological areas to know its effect from soil, crop and climate perspectives. The research study has recognized several advantages of soil physical, chemical and biological characteristics of conservation labour, as well as crop yields, over standard tillage (CT). Agriculture accounts for no less than 25% of greenhouse gas effluxes in the environment. Zero Tillage (ZT) was discovered to be among the environmental friendliest among various laying methods for climate change mitigation and adaptation processes. Conservation tillage with ZT and minimum tillage which is capable of breaking the compact surface area into soil with decreased ground disruption therefore provides better soil environments and crop yields with minimum environmental impact (Abolanle, Singh, Kaur, Bhatt, & Ally, 2015).

Conservation Agriculture (CA) techniques require minimal soil repetition, continuous soil coverage by plant or crop residues, and plant revolutions for greater productivity. In India, attempts have been ongoing for almost twenty years to develop, refine and spread conservation-based agricultural technology, and since then, important progress has been made, although CA has been subject to several limitations. In particular, huge attempts have been created to keep wheat in the Indo-Gangetic plains under rice-wheat rotation. There are more benefits than compensation payments for CA adoption, but both adopters and promoters understand the balance between the two. CA techniques provide possibilities to decrease manufacturing costs, save water and

nutrients, boost returns, enhance crop diversification, enhancing resource efficiency and environmental benefits. However, restrictions still exist to promote CA technology, such as the absence of adequate seeds for tiny and medium-sized farmers, competition between CA use and feeding of livestock crops, fueling of crop residues, the availabilities of qualified and science workforce and the elimination of prejudicial behavior and mentality regarding labour. CA in the area needs to be promoted urgently to create the policy framework and policies. This paper reviews emerging concerns arising as traditional agriculture schemes are continuously adopted and analyzes the limitations, opportunities, policies and study requires for preservation agriculture in India (Bhan & Behera, 2014).

The main reactions to the stagnant crop yields and decline of the profitability of rice and wheat farmers in the Indo-Gangetic Plains emerged with the preserving of resources that include zero-till planting of wheat, bed planting of crops, lasers aided land leveling etc. The evolutions and rapid implementation of zero tillage is an important step towards more extensive agriculture conservation schemes that include retention of crop residues on land and suitable crop rotations. The widespread use of new techniques is ascribed to farmers in terms of lower manufacturing expenses, improved productivity and effectiveness in inputs (R.K. Malik, 2005).

The RCT includes laser leveling, no tillage, furrowing technique and crop residue management. These techniques have been assessed in the rice-following wheat irrigation fields of Punjab province. The effectiveness of water use in laser level areas was improved by 20 percent. Zero-tillage technology saved significantly (22%), fuel (78%), farming (88%) and use of herbicides in comparison with standard ones, thus improving returns and farmers' incomes. Soils, bacteria, fungus and accuracy enhanced in zero-till areas and the microbial population (Mann *et al.*, 2008). (Tripathi, Raju and Thimmappa, 2013) compared the economy of wheat manufacturing in Haryana to zero tillage and standard techniques and evaluated the technology and input contribution of zero tillage (ZT) increases in efficiency.

In the ZT technique, net revenue was discovered to be greater primarily because of the reduced manufacturing costs compared to standard ones. The research found that ZT technology can provide farmers with extra revenue and assist to conserve scarce resources. Although the implementation of ZT technology was restricted and a significant constraint was identified, which was the difficulty accessing a zero seed drill during a seedling era. Despite several financial and environmental benefits The research showed that ZT technology should be dissipated on a broader level and a customized hiring basis at least should ensure the availability of zero-till seed drill.

The agricultural conservation scheme not only increases soil quality but also increases crop yields adequately. Various scientists report that crop yield improves substantially under conservation labour (Hemmat and Eskandari, 2006; Huang *et al.* 2008).

Ijaz *et al.*, 2007 conducted experiments using different tillage practices with and without application of straw mulch. In the two-year research, MT showed considerably low effectiveness in the fallow and water content of wheat seed (15-23 percent). However, there were no important variations in soil humidity storaging in both the 4 Mg ha^{-1}. They proposed that further study is required to discover the highest rate of wheat straw and methods to manage residues to quickly decompose at extremely high summer temperatures and in the region, particularly for the conservation tillage scheme, for a longer period. A comparative research was performed on the conventional tillage by the farmer, with the retention of residues and with the removal of wheat and oate plants. They said that the crop yields and associated characteristics in carved and no-till plots did not differ substantially (Mohammad *et al.* 2006).

Khan *et al.*, 2011 compared the impact of a moldboard grower and tine cultivator on mungbean yield under the Dera Ismail Khan, khyber Pakhtunkhwa rainfed circumstances. After a two-year research, the output of tine cultivators was greater than moldboard plow.

Conservation Agriculture (CA) has several benefits in the fields of soil health parameters compared to standard tillage (CT) agriculture. Weeds, however, are the main biotic restriction in CA and pose a huge challenge in their implementation. In addition, owing to the absence of a tillage procedure, weed seeds are present on the upper surface of the soil which causes more CA weed infestations. The effect on environmental pollution, weed shifts and the growth of herbicide resistance in plants was demonstrated by the dependence on herbicides. A widespread weed management method to address weed change could be used to grow herbicidal-tolerant using no selective herbicides, although it also leads to the development of more difficult' super weeds.' These findings show the need for integrated weed management techniques incorporating culturally tested methods. Competitive crop varieties, mulch, plant cushion, allopathic plant interplants, diversification of plants, geometry planting, effective nutrient management, water management, etc., together with site-based implementation of herbicides. Modern seeding facilities such as ' Happy Seeder ' technology, which supports the management of weeds as mulch retention and the effective positioning of seed and fertilizer, show the commitment that this is an essential feature in the CA scheme (Singh *et al.* 2015)

Conservation Agriculture (CA) is an option to tillage, with numerous advantages as far as productivity and sustainability are concerned, with a farming approach based on three principles of minimum soil disruption (or direct seeding) with continuous vegetative soil cover and crop rotation. The first two key principles of CA call for dedicated equipment to seed unploughed residue fielding, crop cover management, plant residue management and weed management. It is not surprising that almost 97% of the global 155 million hectares in the CA industry is large-scene commercial farming with two thirds of CA being mechanizing and using specialized equipment. Direct seeding and soil-cover management are, in principle, the weaker connections of the CA adoption chain without access to suitable farming equipment (Mkomwa *et al.*, 2015).

Conservation agriculture (CA) has been promoted as an important manner of achieving viable agriculture by defending soils against degradation. The nutrient management in CA is at the heart of this section. The management of crops and their effects on the management of nutrients with an emphasis on three important principles of CA laying, crop rotation and residue management is provided specific attention. The management of nutrients in CA has gained little attention even though it does not only affect crops but also the tolerance of plant crops towards pests. Additional nutrient management study could enhance globally CA acceptance. CA also requires the development of genotypes to improve the nutrient use effectiveness as weeds, insect pests and illnesses are controlled. In order to improve plant productivity and generate adequate crop residues under the distinct climates in which CA is practiced it is also crucial for the proper use of fertilizers and nutrients (Christos *et al.* 2015).

Conclusion

Results of different research studies indicate that CA increase organic matter contents improve soil structure, provide equal yield and economic benefits by decreasing input cost in soil bed preparation. To decrease cost of production and increase economic benefits CA is recommended. However, there is a need to establish long term, multi-location and multi-disciplinary collaborative research on different engineering and agronomic aspects of CA to draw clear long term conclusions.

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