Zero Tillage: A Future Friendly Way of Farming

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There is increasing awareness all over the world of the negative effects of conventional agriculture and the need to change traditional agricultural practices. The key problem conventional agriculture faces, especially in the tropics, is the steady decline in soil fertility, which is closely correlated to the duration of soil use. This is primarily due to soil erosion and the loss of organic matter associated with conventional tillage practices, which leave the soil bare and unprotected in times of heavy rainfall, wind and heat (Derpsch, 2003). To counter this new concept of farming is evolving, which has been termed "conservation agriculture". Conservation agriculture maintains a permanent or semi-permanent organic soil cover. This can be a growing crop or dead mulch.

Conservation agriculture aims to conserve, improve and make more efficient use of natural resources through the integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well as to enhanced and sustained agricultural production (FAO, 2001). Zero tillage, minimum tillage, direct sowing, direct drilling and conservation tillage all aim to achieve conservation agriculture.

Zero tillage is conservation agriculture technology where seed is placed into soil by seed drill (zero till-drill) without prior land preparation (Singh et al., 2016). According to the initiators of the system in the 1960s,it is defined as "Planting crops in previously unprepared soil by opening a narrow slot, trench or band only of sufficient width and depth to obtain proper seed coverage. No other soil preparation is done" (Phillips and Young, 1973). It is known as extreme form of minimum tillage as no soil disturbance is done in case of zero tillage. In case of zero tillage, primary tillage is completely avoided and secondary tillage is restricted to seedbed preparation in row zone only. It is also known as no-till as it is resorted to where soils are subjected to wind and water erosion, and time is too short for tillage operation and also when requirements of energy and labour are too high. Zero tilled soils are homogenous in structure with more number of earthworms The organic matter content increases due to less mineralisation Surface runoff is reduced due to the presence of mulch. The favourable effects of zero tillage on soil physical properties are apparent after two years of its practice.

History of zero tillage

Table 1: Historical events related to Zero tillage in the world

Year	Event
1930	Great dust bowl occurred in mid-west USA.
1940	Development of direct seeding machinery, first no-till sowing
1945	Book on no-till in modern agriculture entitled "Plowman's Folly" by Edward H. Faulkner.
1955	Invention of Paraquat in 1955 by Imperial Chemical Company, UK
1961	First Commercial release of paraquat by ICI to initiate no till research in UK, USA
1961-62	Demonstration trial in USA by Harry and Lawrence Young from Herndon, Kentucky – 1st farmer to adopt no-till technology
1975	"One Straw Revolution" book by Masanobu Fukuoka
1990s	New generation machines for no-till seeding under conservation agriculture.

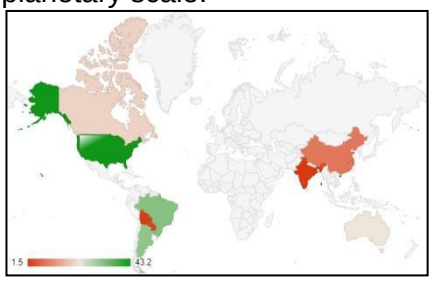
Table 2: Historical events related to tillage in India

Year	Event
1970	Start of ZT research but lack of adequate planting equipment and weed control difficulties.
1990	Peter Hobbs (Regional wheat agronomist, CIMMYT, Ludhiana) introduced inverted-T openers for drilling seed to Indian researchers.
1991	First prototype of Indian ZT seed drill was developed at G.B.P.U.A. & T., Pantnagar
1990s	In Haryana, ZT was introduced to tackle menace of *Phalaris minor*.
1992–1993	Development and commercialization of ZT initiated with

	small-scale industries in India

Extent of Adoption of Zero Tillage Worldwide

The global uptake of Conservation Agriculture (CA) has witnessed a remarkable expansion, with millions of hectares of arable cropland adopting this sustainable farming approach. As agricultural communities around the world increasingly recognize the benefits of CA in promoting soil health, water conservation, and biodiversity preservation, its adoption has surged across diverse agro-ecological regions. From the vast plains of North America to the terraced hillsides of Southeast Asia, farmers are embracing CA practices such as minimal soil disturbance, permanent soil cover, and diversified crop rotations. This widespread adoption reflects a growing recognition of the urgent need for more resilient and ecologically sound farming systems in the face of climate change and environmental degradation. As the global uptake of CA continues to accelerate, it holds the promise of transforming agriculture into a force for environmental stewardship and sustainable development on a planetary scale.



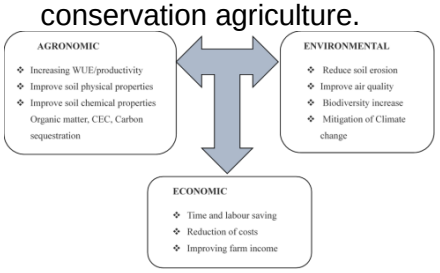
Global scenario of zero tillage (mha)

Adoption of Zero Tillage in India

- In India's rice–wheat systems, adoption of ZT is primarily in the wheat crop and concentrated in the north-western IGP (Laxmi et al., 2007).
- In India, presently it occupies 1.5 m ha area mainly in IGP (FAO-AQUASTAT, 2015-16).
- In the IGP, the prevailing ZT technology uses a tractor drawn ZT seed drill having inverted-T openers for dropping seed and fertilizers simultaneously and directly into untilled fields (Singh et al., 2017).

Advantages of Zero tillage

- Declining factor productivity: Factors like water crisis, non-availability of labour, energy Declining factor productivity: Factors like water crisis, non-availability of labour, energy crisis, declining soil fertility, pollution hazards, reduction in SOM etc. leads to declining in factor productivity in agriculture.
- Ever-increasing production cost: Due to inefficient use of water, fertilizer and agriculture inputs, production cost increases.
- Pollution hazards: Due to excessive use of pesticides and fertilizer in intensive agriculture, groundwater as well as rivers, ponds and lakes are polluted.
- Deteriorating soil health: There is destruction of soil structure due to use of heavy machinery in intensive agriculture. Soil pores are closed and BD increase which leads to reduction of infiltration rate and increasing runoff. Thus, essential nutrients are washed away from top soil. Due to the removal of crop residue, reduction in SOM as well as problems of decreasing soil microbial population arises.
- Higher global warming potential: Climate change now a days major challenge in agriculture. Due to adverse effect of climate change, emission of GHGs like CO2, CH4, CFC and N2O occurs which is declining the crop production.
- High surface water run-off and erosion: Due to use of heavy machinery, there is formation of hard
- Declining/stagnating yield trends and farm income: Ultimately, there is declining in crop yield and farm income which can be recovered by conservation agriculture.



Conclusion

In conclusion, the journey through the history and advantages of zero tillage unveils a compelling narrative of agricultural innovation and sustainability. From its humble beginnings as a novel concept to its widespread adoption as a cornerstone of modern farming practices, zero tillage has reshaped the landscape of global agriculture. By minimizing soil disturbance, preserving soil structure, and reducing erosion, zero tillage offers a multitude of benefits for both farmers and the environment. Through improved water retention, increased organic matter accumulation, and enhanced biodiversity, zero tillage not only boosts crop productivity but also fosters long-term soil health and resilience. Furthermore, its role in mitigating greenhouse gas emissions and mitigating climate change underscores its significance in the quest for a more sustainable future. As we look ahead, the continued promotion and adoption of zero tillage hold the promise of transforming agriculture into a powerful force for environmental stewardship and food security. Embracing the lessons of history and harnessing the advantages of zero tillage, we can cultivate a

brighter, more sustainable tomorrow for generations to come.

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