Vol.1 Issue-5, January 2021

JUST AGRICULTURE multidisciplinary e-Newsletter

Tillage Practices for Enhancing Crop Productivity under Dryland Conditions

Sanju Choudhary[1], Biswajit Pramanick[1], Sagar Maitra[2] and Biresh Kumar[3]
[1]Department of Agronomy, Dr. Rajendra Prasad Central Agriculture University, Pusa, Bihar
[2]Department of Agronomy and Agroforestry, Centurion University of Technology and Management,Paralakhemundi, Odisha
[3]Senior Technical Officer, Department of Plant Breeding and Genetics, Tirhut College of Agriculture, Dholi, Muzaffarpur.

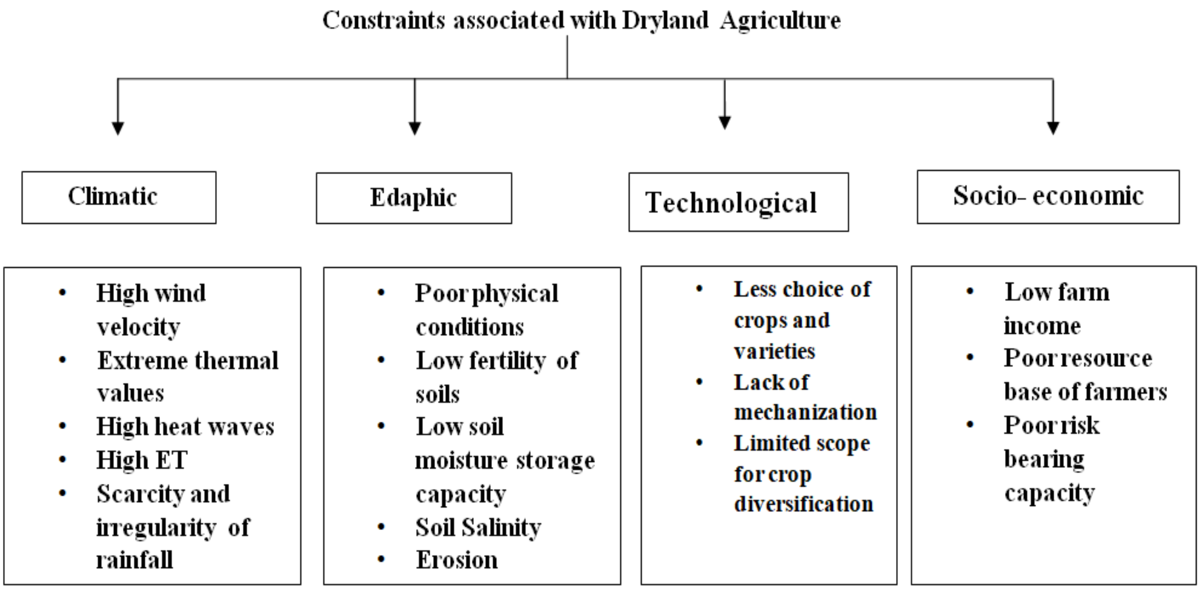
ARTICLE ID: 045

Introduction

Dryland agriculture is mainly dependent on rainfall, especially in India, where the quantity and distribution of monsoon rain determine crop production. Soil water is the main limiting factor in the production of crops under dryland conditions Since food production in India largely depends on the action of the monsoon, many efforts have been made to understand and predict the variability of the monsoon. Yet the variability of the summer monsoon is still less predictable. Therefore in order to control soil erosion and effectively store and use the limited precipitation received for crop production, farmers must manage crop residues and tillage. Tillage is a physical operation of soil, which aims to destroy weeds in the incorporate crop residues and amendments into soil, reduce evaporation, increase infiltration, and break hard layers to assist root penetration. There are different kinds of tillage operations such as conventional tillage, no-tillage, reduced tillage etc. Conventional tillage practices and crop residue removal will lead to a decrease in soil organic matter due to accelerated decomposition and loss of topsoil, thereby adversely affecting soil properties. Recently, reduced tillage practices have been gaining popularity. Conservation tillage techniques, which are soil-surface crop residue management systems with minimum or no-tillage(Kar *et al.*, 2021) are crucial in efficiently saving more precipitation for crop production. Adoption of conservation tillage practices, which include no-tillage and several forms of reduced minimum tillage is a means to increase soil organic matter (SOM), mitigate CO_2 emissions and partly address the rising environmental problems associated with modern agricultural practices because of the potential of this practice to reduce soil erosion, conserve soil

JUST AGRICULTURE multidisciplinary e-Newsletter

moisture and improve soil structure. Like several other factors, proper land preparation with different tillage practices plays an important role in improving the production of drylands by moisture conservation. Crop rotation and tillage system could affect crop yield due to their effects on water conservation and soil chemical and physical properties. In semi-arid conditions, conservation tillage may reduce evaporative water loss and increase crop biomass thereby favouring organic matter accumulation from the higher input of residues (Campbell and Janzen, 1995). Higher yield is usually attributed to increased water conservation or utilization by the crop, especially in arid and semi-arid regions; lower yield is attributed to greater disease and weed infestations and N immobilization.



How tillage practices can help in dryland farming?

A. Conventional form of tillage:

Conventional tillage is the traditional method of farming in which soil is prepared for planting by completely inverting it with a tractor-pulled plough, followed by subsequent additional tillage to smooth the soil surface for crop cultivation.

Improves infiltration (deep tillage):

Subsoil cultivation is a technique that cuts soil deeper. It helps to improve grain yield by deep and prolific root growth of crops and improves infiltration also because the primary modifications of the rhizosphere are mainly due to cutting and inversion action of deep tillage that results in a reduction in bulk density and an increase of macropores in soil.

Helps in better weed management:

Shallow soil cultivation in between the crop is done to suppress weeds, to reduce the evaporation of the soil moisture from the deeper soil layers and to stimulate the decomposition of organic matter, thus making nutrients available. If weed pressure is high, seedbeds can be prepared early thus allowing weed seeds to germinate before the crop is sown for being eliminated after some days with shallow soil cultivation.

Improves soil physical condition:

Deep tillage is normally implemented to increase the soil moisture-holding capacity through increased porosity, to enhance infiltration rates, and to reduce the surface runoff by providing surface roughness. It also allows for the proliferation of roots to exploit soil water and nutrients at deep horizons. Farmers should be conscious when soil compaction is an issue. Deep tillage and cultivation of deep-rooted plants in dry conditions can help restore soil compaction(IFOAM, 2001).

Inter cultivation acts as dust mulch:

In conventional tillage repeated cultivation has been done which loosened the surface of the soil, and it acts as mulch for reducing evaporation. This loose surface soil is called soil mulch or dust mulch. Intercultivation creates soil mulch in a growing crop.

Under certain circumstances, tillage implements compact soil particularly under ploughshare, and smear or puddle soil when cultivation operations are conducted in the plastic state. Furthermore, the high energy demands of conventional tillage operations in a world where energy is increasingly becoming expensive have necessitated a re-thinking of its use. Increasingly ‘conservation tillage’ systems that lower energy inputs and prevent the structural breakdown of soil aggregates would have to be adopted in dryland areas.

B. Conservation form of tillage:

Conservation tillage is characterized as any tillage or planting method in which to minimize water and wind erosion, at least 30 percent of the soil surface is covered by plant residue.

Minimum soil disturbance:

To minimize soil erosion and improve water quality, this is the most effective conservation practice.No-tillage based crop residue cover and infiltration rates optimize the volume reduction of farm runoff and contaminants(Evans *et al.*, 2000).

Maintaining soil cover

Residue retention by conservation tillage can improve soil structure and nutrient cycling over the long term. Research reported no-tillage practices improve soil aggregation, C storage(sequestration) and aggregate stability. The increase in aggregate stability leads to increased infiltration of soil water and resistance to wind and water erosion.

- Enhance water infiltration: To avoid soil compaction and improve the soil infiltration rate, soil cover can help to protect the soil surface from aggregate destruction.
- Helps to maintain soil temperature: Soil cover or crop residue retention on soil surface helps to maintain soil temperature under dryland conditions. Bare soils absorb heat and become very hot during summer very quickly and becomes very cold during winter.
- The energy of raindrop falling on bare soil result in destruction on soil aggregates, clogging of soil pores and rapid reduction in water infiltration with resulting run-off and soil erosion.

Soil and water conservation practices: Soil and water conserved through by applying

- Minimum tillage
- Crop residue management
- Mulching

A key element of conservation tillage is considered to be water conservation, especially in dryland areas exposed to erratic and unreliable rainfall. To demonstrate the effects of mulching on infiltration of rainfall. Conservation tillage when it includes, crop residue as mulch, maintains organic matter level, conserves water and soil and soil structure. Protection of the soil against raindrop impact, the decrease in flow velocity by imparting roughness, and enhanced infiltration capacity are the beneficial effects of mulching. It can improve the effectiveness of no-till in enhancing soil moisture and reducing soil losses.

JUST AGRICULTURE
multidisciplinary e-Newsletter

Reduction in cost of production:

The conventional tillage operations are expensive and require high farm labour supply while reduced tillage implied economy in time, labour and petroleum.

Enhancement of soil quality:

Reducing tillage has a beneficial effect on many aspects of the soil, while unsustainable and unnecessary tillage operations give rise to opposite soil-damaging phenomena.Therefore currently there is a significant interest and emphasis on the shift from extreme tillage to conservation and no-tillage methods for the purpose of controlling the erosion process. Conservation tillage methods leave the soil intact. The number, size, and distribution of pores influence the soil's ability to store and diffuse the air, water, and agricultural chemicals and thus regulate erosion, runoff, and crop performance. Losses of soil organic C and deterioration in other properties exaggerated where conventional tillage was employed. With time, conservation tillage on the other hand improve soil quality indicators including SOC storage.

Enhancement of production and productivity:

Conservation tillage practice performs better in terms of improvement of edaphic and yield influencing characters of the specific and unearth soil-water-plant ecosystem of the region (Alam, 2010).

Weed management and mechanization:

The dynamics of the weed population in conservation agriculture is completely different from traditional system; in conservation agriculture practices, the eco-physiological responses of weeds and their interaction with crops tend to be more complex and not always well understood. In the absence of tillage and timely management, perennial weeds may also become a major issue. However several examples of effective weed management under CA have been published (Farooq *et al.*, 2011). In most dryland conditions in developing countries, adoption of CA can be hindered by the availability of effective herbicides. Alternative approaches such as stale-seed-bed technique, use of cover crops and crop residues, uniform and dense crop establishment, crop rotations and practices for enhanced crop competitiveness with a combination of pre- and post-emergence herbicides and adapted small-scale planters could be integrated to develop sustainable weed management strategies under conservation agriculture systems (Johansen *et al.*,2012).

Residue management:

The shift of crop production systems to CA and retention of crop residues has been reported to cause progressive qualitative and quantitative changes in soil organic cover, affecting the soil water balance, biological activity and accumulation of soil organic matter (Kassam *et al.*,2012). However, it is evident that organic resources are often the most limiting factor in dryland areas, where crop residues are usually used to feed livestock.

Why conservation agriculture is needed under dryland conditions?

- It is conserve soil and moisture
- Water is limiting factor in dryland agriculture so conservation of moisture is needed.
- Total cultivated area of India is 143 M ha out of which 108 M ha area is under dryland.
- Conservation agriculture balances yields, resource conservation and increased efficiency for smallholder farmers.

Conclusion:

It is concluded that ploughing up to 30cm deep across the slope is more effective for maximum moisture conservation. The soil had considerably higher moisture content under conventional tillage than the reduced till, mulch till and no-till treatments. The implementation of minimum tillage systems increased the organic matter content and water-stable aggregate content, in the 0 - 30 cm depth, as compared to the conventional system. For zero tillage, the costs are a function of the cost of chemicals. In general terms, conservation tillage practices are cheaper than conventional tillage due to the reduced demand for ploughing, but are subject to some opportunity costs at the time of conversion from conventional tillage.No-till in rotation with sub soiling is the one of the best option to improve crop productivity, soil water storage and WHC.

References:

Alam, M.K., 2010. Effect of tillage depths and cropping pattern on soil properties and crop productivity. Department of soil science, Bangabandhu Sheikh mujibur Rahman agricultural university.

Campbell, C.A. and Janzen, H.H., 1995. Effect of tillage on soil organic matter. In: Farming for a Better Environment. Soil and Water Conservation Society, Ankeny, pp. 9–11.

Evans, M.G., Eck, K.J., Gauck, B., Krejci, J.M., Lake, J.E. and Matzat, E.A., 2000. Conservation tillage update: keeping soil covered and water clean in the new millennium. Clean Water Indiana Education Program. Purdue University, Agronomy Department.

Farooq, M., Flower, K.C., Jabran, K., Wahid, A. and Siddique, K.H.M., 2011. Crop yield and weed management in rainfed conservation agriculture. *Soil Tillage Research*117: 172–183.

IFOAM, 2001. Training manual on organic agriculture in the tropics.

Johansen, C., Haque, M.E., Bell, R.W., Thierfelder, C. and Esdaile, R.J.2012. Conservation agriculture for small holder rainfed farming: opportunities and constraints of new mechanized seeding systems. *Field Crop Research* 132: 18 – 32.

Kar, S., Pramanick, B., Brahmachari, K., Saha, G., Mahapatra, B.S., Saha, A. and Kumar, A. 2021. Exploring the best tillage option in rice based diversified cropping systems in alluvial soil of eastern India. *Soil and Tillage Research* 205: 104761.

Kassam, A., Friedrich, T., Derpsch, R., Lahmar, R., Mrabet, R., Serraj, R., Basch, G. and González-Sánchez, E.J.2012. Conservation agriculture in the dry Mediterranean climate. *Field Crop Research*132: 7 – 17.