Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 3 (3) February 2014: 283-296

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804

REVIEW ARTICLE

Affect Conservation tillage on Sustainable land use: A review

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ABSTRACT

The need for land management technologies and policies that provide long-term sustainability as well as high levels of productivity is generally accepted in the World, but this will have to operate within the constraints of market conditions and political and social expectations. However, acceptable methods of assessing sustainability of farming practices are often questioned by the farming community. Therefore, development of broadly applicable framework for evaluation of sustainable land management needs urgent attention by the researchers and policy makers and the assessment techniques need to take into account the widely varying factors influencing sustainability in different farming systems.Conservation tillage, defined as any planting practice or tillage operation that leaves at least 30% of the soil surface covered with crop residues, has long been recognized for its ability to reduce soil loss from water and wind erosion. The crop residues left on the soil surface in conservation tillage systems influence the water cycle through two main effects; increased infiltration and reduced evaporation. Crop residues protect the soil from the impact of raindrops, thus reducing soil crusting, and slow lateral movement of water, allowing it to infiltrate into the soil. Conservation tillage can result in significant reductions in erosion and water loss while improving the soil for agricultural production.

Keywords: *land management technology, Conservation tillage, crop residues, Sustainable land use.*

Received 02/12/2013 Accepted 21/01/2014

INTRODUCTION

The goal and basic challenge of sustainable land Management (SLM) is to make better use of available biophysical and human resources in a given area. SLM implies that government and major stakeholders place among their priorities, the implementation of appropriate policies and coordinated interventions, which will lead to five objectives:

- more rational land use,
- fair access to land resources,
- improved land management practices,
- avoidance of land degradation,
- Development of an updated knowledge and information base. (Lal et al., 2000).

The movement for sustainable agriculture is growing in movement throughout the world and the Pacific region is no exception. It exhibits widely varying climatic conditions from arid through warm and cool temperate to tropical; and soil ranging from volcanic to loess. Soil erosion, crop production and pasture improvement and their management flexibility and moisture conservation are sufficient incentives to keep sharp focus on soil conservation technologies. The provision, therefore, of biologically tolerant crop production technologies capable of adaptation to a wide range of soil and climatic conditions is an important prerequisite to the large-scale change from tillage to conservation tillage technology. [28]

Rotation of permanent pastures with forage crops using conventional tillage is a common practice. Establishment of crops using conventional tillage is popular. However, such operations are not sustainable because of the decline in soil physical, chemical and biological properties, there is a growing acceptance of conservation tillage as an efficient method of crop establishment, but its application is mainly limited to use with establishing pastures and forage crops. This has been partly because some conservation tillage research shown that no-tillage is associated with higher soil bulk density, soil strength and aggregate stability.

The basic principles of conservation tillage agriculture include the following:

1) Growing crops without using traditional tillage.
2) Using special planting equipment that cuts through the residue mulch.
3) Using seeders that require four-wheel tractors, although the seed can dibbled in by hand (often using sticks to make the opening), or some small equipment suitable for animals or hand tractors.
4) Retaining surface residue that reduces erosion, evaporation and limits weed growth.
5) Sowing directly into the soil covered by residue mulch.
6) Improving water infiltration capacity by ameliorating effects of residue mulch which provides bioturbation and enhances macro-porosity despite some increase in bulk density. [7]

Conservation tillage, zero or minimum tillage, is one of the practices that has proved to combat soil degradation efficiently. While millions of hectares of farm land are already under zero tillage in Latin America, in Africa and Asia. Conservation tillage is restricted mainly to larger estates. There are, however, enough examples demonstrating that conservation tillage can be practiced successfully by small holder farmers too. Yet much work is needed to demonstrate that the technology works in order to change the mindset of farmers who for many years were taught or learned from their parents that it is necessary to plough and maintain a weed free field for better crop production. Conservation tillage is consisting of: (Fig 3 and 4) [23].

Figure 1. No till farming and other conservation tillage practices

1. No-tillage

The soil is left undisturbed from harvest to planting except for plant nutrient application. Any tillage system that causes less than 25% of row width disturbance by planting equipment (e.g., coulters, disk openers, in-row chisels, roto-tillers) is considered a no-tillage system. Weed control is primarily through herbicides, but cultivation may be used for emergency weed control. (Fig 1 and 2) [23].

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Figure 2. No-till soybean seeded through the crop residue

2. Ridge-tillage

The soil in ridge-tillage is also left undisturbed from harvest to planting, except that planting is completed in a seedbed prepared on ridges with sweeps, disk openers, coulters or row cleaners. Residue is left on the surface between ridges. Weed control may be accomplished with herbicides and/or cultivation. [23].

3. Mulch-tillage

The soil is disturbed prior to planting by tillage tools such as chisels, field cultivators, disks, sweeps or blades. Weed control is accomplished with herbicides and/or cultivation. [23].

4. Reduced-tillage

Any seedbed preparation system that leaves 15 to 30% residue cover after planting or 500 to 1000 kg/ha of small grain residue equivalent throughout the critical wind erosion period is considered a reduced-tillage system. [23]

5. Conventional-tillage

Tillage methods that leave less than 15% residue cover after planting or less than 500 kg/ha of small grain residue equivalent throughout the critical wind erosion period come under the category of conventional-tillage systems. [23]

Figure 3. The five field plots with (from left to right) conventional tillage CT, sub soiling SS, two crops 2C, no tillage NT and reduced tillage RT.

LIMITATIONS OF CONSERVATION TILLAGE

1) Weather conditions

In terms of yields, the best tillage system is often a function of the weather experienced in that year [24]. Weather conditions in the growing season also appear to play a part in the success of no-till systems. A review by Riley et al in 1994 indicated that in Norway, better results were often observed in dry years than in wet years. Eckert 1984 in reported no-till corn yielded more in drier than in normal years, whereas in the moderately well-drained soils of Ohio the yields with moldboard plow were higher in wetter rather than in normal years. No-till yields were 5%-20% lower than with the moldboard plow system in wet years, but were 10%-100% higher in relatively dry years. In years of low rain, no tillage had a yield advantage over tillage methods.

2) Soil types

Changes in soil structure could affect the relative success of conservation tillage. Studies in Canadian brown and dark brown soil zones showed that the effects of tillage systems on yields of barley, winter wheat and spring wheat varied from year to year but were, on average, equal. [20] In the North Central and Northeastern USA weather and soil type strongly affected the relative success of reduced and no-till methods with fine-textured and poorly drained soils generally posing the greatest challenge to their adoption. [24] Studies also documented several potential benefits associated with conservation tillage:

1) Potential carbon sequestration with smaller carbon emissions due to slow oxidation under low temperatures with no-till,

2) Potential nutrient availability where adequate fertilizer inputs were generally more critical with conservation tillage systems (particularly no-till) than with conventional tillage systems and over the long term, requirements could decline **as** a result of accumulation and mineralization of organic matter [34]

3) Potential yield response where even though the crop yields with no-till was not usually reduced.

Several benefits from conservation tillage systems have been reported: (Fig 5)

1) Economical benefits (such as labor, energy, machinery cost and time saved),
2) Positive effects from erosion protection and soil and water conservation,
3) Increases in soil organic matter,
4) Improve soil quality,
5) Improve Soil chemical property,
6) Improve soil physical property. [49, 23]

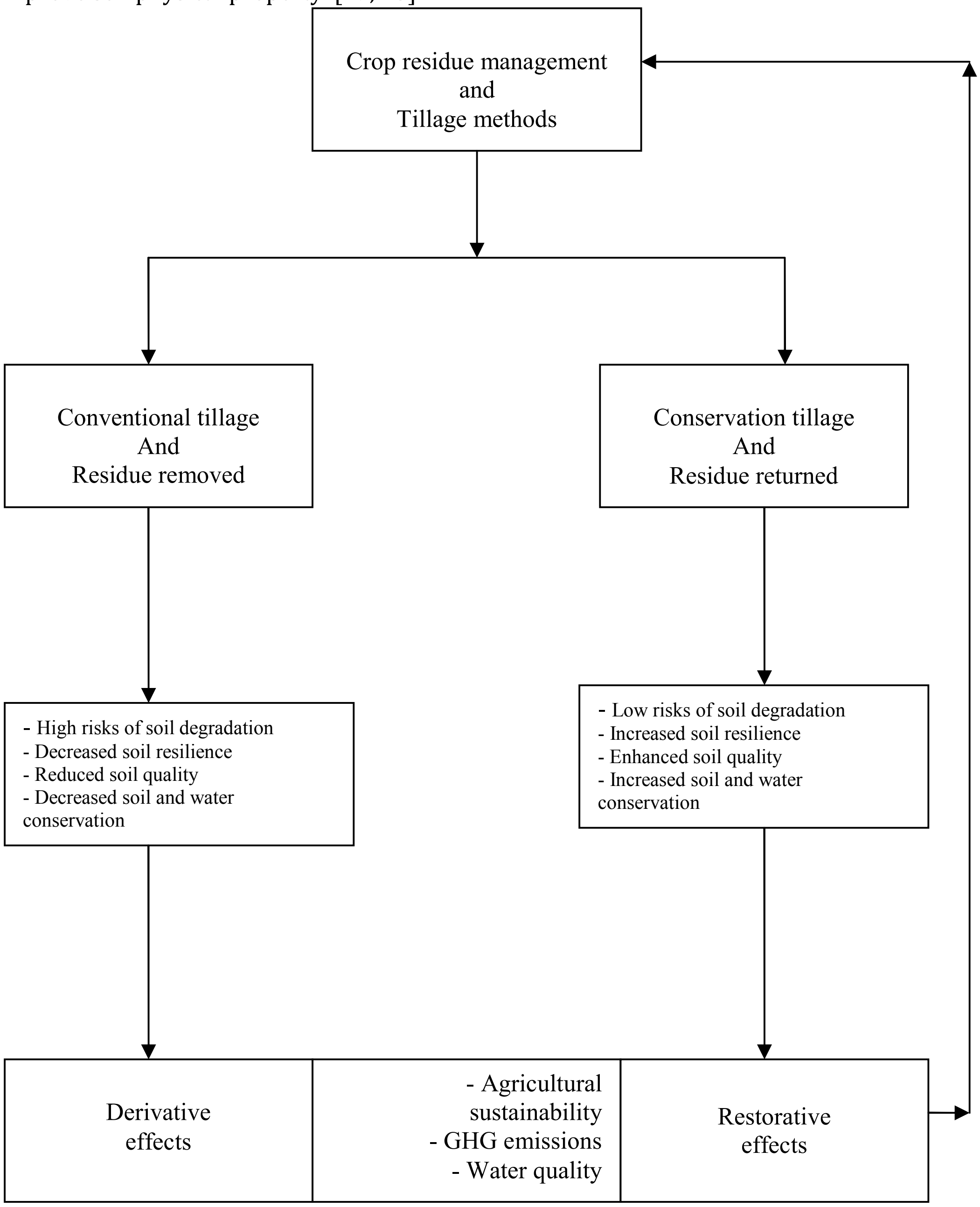

Figure 5. Interaction between soil degradation, soil resilience, soil and water conservation and soil quality as influenced by tillage method and residue management (GHG = greenhouse)

Affect conservation tillage on Soil Carbon séquestration

The term ''soil C sequestration'' implies removal of atmospheric CO2 by plants and storage of fixed C as soil organic matter. The strategy is to increase SOC density in the soil, improve depth distribution of SOC and stabilize SOC by encapsulating it within stable micro-aggregates so that C is protected from microbial

processes or as recalcitrant C with long turnover time. In this context, managing agro ecosystems is an important strategy for SOC/terrestrial sequestration. [38]
Determining the effects of residue removal and tillage systems on surface crop residue accumulation, organic carbon sequestration is essential for sustainable land management. Tillage methods, enhances mineralization of SOC and releases CO2 into the atmosphere. Tillage increases SOC mineralization by bringing crop residue closer to microbes where soil moisture conditions favor mineralization. The SOC pool declines due to cultivation and soil degradation. [26]
Soil organic carbon dynamics based on data from 10-year field experiments with residue, manure and fertilizer applications in dry land maize production systems in northern China suggested that with conservation tillage practices at least 50%, on average, of the crop residue should be returned to the soils to maintain acceptable organic carbon levels [48]
Conservation tillage, a generic term implying all tillage methods that reduce runoff and soil erosion in comparison with plow-based tillage, is known to increase SOC content of the surface layer. Principal mechanisms of carbon sequestration with conservation tillage are increase in micro-aggregation and deep placement of SOC in the sub-soil horizons. Other useful agricultural practices associated with conservation tillage are those that increase biomass production. Relevant to adopt soil and crop management systems that accentuate humification and increase the passive fraction of SOC. Because of the importance of C sequestration, soil quality should be evaluated in terms of its SOC content. [22] Depending on planting frequency, increases in soil C may take 5-10 years to come into effect. Between 1986 and 1994 organic C concentration under direct seeded continuous wheat changed from 1.75% to 1.83%. Over the same time period for a direct seeded/chemical fallow wheat-fallow rotation, the change was from 1.63% to 1.60%. [7]
Benefits of adopting conservation tillage for SOC sequestration are greatly enhanced by growing cover crops in the rotation cycle. Growing leguminous cover crops enhances biodiversity, the quality of residue input and SOC pool. They are well established that ecosystems with high biodiversity absorb and sequester more C than those with low or reduced biodiversity. [15
] In Georgia, USA that improved forage management can enhance the SOC pool. However, the use of cover crops as a short-term green manure may not necessarily enhance the SOC pool. [14]
Conservation tillage, including NT as a means to sequester C in soils and revert degradation processes. It is recognized in temperate zones and recently in tropical regions that implementation of conservation tillage (mainly NT) can restore soil organic carbon (SOC) levels of previously degraded lands. [40]
Lal, [23] in Nigeria found, higher SOC in the surface soil horizon (0–10 cm) of NT (1.30%) than of conventional tillage (0.86%) after 5 years of experimentation. SOM declined by 0.03% per month under CT for the first 12 months of conversion from fallow to continuous maize. However, the decline rate was only 0.004% per month under NT. The difference in SOM content between tillage systems was not sizeable in the (10–20 cm) depth. The effectiveness of soil management practices (rotations, crop residue inputs, manures, conservation tillage) to sustain or increase SOC is climate dependent. Tillage based agricultural systems occur in areas with relatively high potential evapotranspiration (PET) and moderate precipitation (sub-humid to semi-arid climates). [44]
Campbell in 1996, in 13 years study on a silt loam soil (Orthic Brown Chernozem) in semi-arid Saskatchewan, Canada, SOC increased with continuous spring wheat vs. the standard fallow-wheat cropping system. No-tillage provided no increase in SOC in the fallow-wheat system but did result in a moderate increase in SOC in the more intensive continuous wheat system. Results reported from a similar study after 11 years on a clay soil. [7]
Conservation tillage (no tillage and minimum tillage), significantly increased surface crop residue accumulation on the soil surface. In the 0–50 mm surface layer, organic C, microbial biomass C and N, inorganic and total N, and extractable P were approximately twice and MT than with conventional tillage. To obtain the benefits of conservation tillage in the sub-humid tropical region of Apatzingán (Vertisols), where organic matter is rapidly oxidized, it is necessary to leave at least 60% of the crop residue on the soil surface, while in the sub-humid temperate region of Casas Blancas (Andisol), where organic matter is oxidized slower, leaving 30% of crop residue is sufficient[39]
Conservation tillage significantly increased the concentration of organic carbon and macro-organic carbon at the soil 0–8 cm depth, compared to conventional tillage, and significantly improved soil structural stability[8].

Affect conservation tillage on Soil quality

Soil quality refers to its capacity to produce economic goods and services and regulate environment. Soil quality is "the capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health."Soil quality is affected by crop residue management and tillage methods. Maintaining and improving soil quality is

crucial if agricultural productivity and environmental quality are to be sustained for future generations. Increased inputs and technologies in modern agricultural production systems can often compensate for mask losses in productivity associated with reductions in soil quality.
However, increased agricultural inputs not only reduce economic sustainability but also increase the potential for negatively impacting environmental quality. [28]
Karlen selected parameters combined in the proposed soil quality index and gave ratings of 0.48, 0.49, or 0.68 for plow, chisel, or no-till treatments, respectively. This indicated that long-term no-till management had improved soil quality. The prediction supported by using a sprinkler infiltration study to measure the amount of soil loss from plots that had been managed using no-till or moldboard plow tillage. He concluded that no-till practices on these soils can improve soil quality and that the systems engineering methodology may be useful for developing a more comprehensive soil quality index that includes factors such as pesticide and leaching potentials. [19] Soil quality changes during the transition from tillage-based farming to no-till are less dramatic and more variable in the low precipitation (150– to 300– mm annual) zone compared to the higher precipitation (300– to 550– mm annual) zone. Tillage impacts soil quality more than surface residue management or crop rotation and also he obtained, Soil organic carbon (SOC) slowly increased in long-term no-till and approached or exceeded that of nearby undisturbed native soil. Long-term no-till also increased the proportion of aggregates in the larger sized soil fractions. Also see that long-term no-till result in microbial community changes and an increase in the fungal: bacterial ratio. [21]
No tillage promoted surface accumulation of crop residues and was more effective in improving soil quality than mould board system (Fig 6). The beneficial effects of conservation management on soil quality were more noticeable in the surface 0–5 cm than below. [38]

Figure 6. A large modern moldboard plow used in the north-central U.S. agricultural production areas.

Thus, conservation tillage has the potential to maintain crop productivity, protect the soil resource, and improve soil quality. Soil quality is consist of: Soil chemical and biological property and Soil physical property, that have gave in below.

Affect conservation tillage on Soil chemical and biological property

The most of the chemical parameters influenced by the type of tillage practice. No-tillage, increases the soil organic carbon (SOC) content in the upper soil layer from 6.8 to 7.5 mg g-1 soil, available N increased by 6.1%, soil pH, soil CHO, P and K content, Soil carbohydrate content also increased from 3.1 to 4.9 mg g-1, dehydrogenase activity, Alkaline phosphates, protease, and cellulase in other treatments, and they were most sensitive to changes due to tillage management. In contrast, cellulase activity was more (by 31.3–74.6%) in conventional practice than other management practices. Understanding the effects of tillage on soil biological properties, soil quality and agricultural sustainability of sub temperate agro-ecosystems may be improved. Soil CHO is an important source of energy for micro-organisms; therefore No- tillage is suggested to promote biological activity in the soil. This was supported by higher dehydrogenase activity and ratio of CHO–C to SOC in no-tillage as compared with conventional tillage treatments. [29]

A long term tillage experiment established the effects of conventional disc tillage (CT) and three conservation tillage systems, i.e. chisel plough (CP), no tillage (NT) and flexible tillage (FT), on the changes in soil chemical properties. whereas NT caused least chemical degradation, resulting in higher soil organic matter and total N contents. During the 4 years, Significant decreases in soil organic matter, total N, available P, and exchangeable Ca found for some or all tillage treatments[2]

There is available N significantly higher in No-tillage than in other treatments. Similarly, in a 25-yearlong study on Mollisols in Nebraska, organic C, and organic N were significantly greater under No-tillage than conventional tillage in the 0–5 cm soil layer. [43]

Conservation tillage systems leave more organic matter, and have a higher microbial biomass; particularly more denitrifies, facultative anaerobes and aerobic microorganisms in the surface (0-7.5 cm) of soils, but have fewer nitrifiers and aerobic conditions. The net result is potentially greater rates of immobilization and denitrification of applied N, but slower rates of mineralization and nitrification with more organic matter accumulation and a less oxidative biochemical environment. This is reflected in lower fertilizer N availability to crops under conservation tillage as compared with conventional tillage, at least in the initial years of reduced tillage. [18]

Tillage system had a significant effect on electrical conductivity and pH of soils. Soil pH, electrical conductivity, Soil nitrate was greater under NT than under MP. A significant interaction was observed between soil tillage and soil depth. In the 5–15 cm layer, there were no differences in soil electrical conductivity between tillage systems for either crop and also, available P and extractable K were not affected by tillage system, soil depth or type of crop. [38]

Tsuji in japan, studied on effects of tillage on soil conditions and crop growth in a light-colored Andosol. Three tillage methods (NT: no-tillage, RT: no-tillage for summer cropping and moldboard plowing for winter cropping, and CT: conventional rotary tillage to a depth of 15 cm). He employed in combination with crop residue application (+R, −R) and fused magnesium phosphate (FMP) fertilization (+P, −P). Under the combination of NT and +R, diurnal variation of soil temperature at a depth of 5 cm was smaller during the summer cropping season and soil temperature in the daytime was lower during the winter cropping season than under CT. Soil inorganic N concentration at a depth of 0–30 cm was +R > −R and NT > RT > CT. He told that, early growth of summer crops accelerated under NT in comparison with CT, and yields were higher under NT and RT in comparison with CT. On the other hand, winter crop yields were significantly reduced under NT, while they were still higher under RT in comparison with CT. Yields were higher with +R and +P application, respectively, and these effects were more pronounced in winter cropping. The positive effect of FMP fertilization was greater in combination with NT, and that of residue treatment was greater in combination with RT and NT than with CT. He concluded, the best tillage practice for Andosols is RT, and CT for winter cropping. [45]

There is a negative correlation between dehydrogenase activity and soil aeration condition. So, deficient soil aeration conditions under NT might also explain the high dehydrogenase activity. [37]

Murillo proposed, the effects of a traditional tillage (mouldboard ploughing) (TT) and a conservation, reduced tillage (CT) system on the growth and nutrition of a sunflower crop, in a wheat–sunflower rotation, established in a soil Xerofluvent of southern Spain.

The CT method usually increased OM and N, and other nutrient contents in the top soil (0–5 cm), in relation to TT. sunflower plants showed better early growth and higher N concentration in TT than in CT. Concentration and total content of NO_3–N were also greater in TT. He concluded that CT was effective in increasing OM and N in the top soil, that CT greatly reduced early growth and N uptake of the crop but favoured yield formation during drought. [31] Tillage systems significantly affected soil bulk density in the 0 to 200 cm soil depth. No-tillage bulk densities higher than for the other tillage treatments. In the 0 to 50 cm surface layer, organic C, total N, and extractable P were higher with NT than with the average of the other tillage treatments. No-tillage decreased cation exchange capacity (CEC) and soil pH as compared with other tillage treatments. Residual NO_3^--N to a depth of 120 cm under NT and MT was consistently less than with the other tillage treatments. Higher levels of soil organic C, total N, and extractable P and lower concentrations of NO_3^- were directly related to surface accumulation of crop residues promoted by conservation tillage management. [39]

In the surface 0–5 cm, organic matter decreased with increasing tillage and also increased by irrigation. The no-tilled soil had increased values of water-soluble C, dehydrogenase, soil protein, urease and acid phosphatase activities, aggregate stability and glomalin compared to tilled soils, especially in the shallowest (0–5 cm) layer. [38]

Affect conservation tillage on soil physical property

Tillage methods affect soil physical properties and have a direct influence on the replenishment and depletion of soil water storage and crop performance. [2]Conservation tillage increases the amount of crop residue left in the soil after harvest, thereby reducing soil erosion and increasing organic matter, aggregation, water infiltration, and water holding capacity compared with conventional tillage [4]. Conservation tillage has the potential for increasing soil organic matter content and enhancing soil aggregation. Conservation tillage systems can create an aggregated, fertile surface layer that is important from a soil erosion reduction perspective and thus for a sustainable agriculture. Some indigenous tillage systems can be adapted to meet objectives of conservation tillage systems. Further, recent technological developments in tillage and seeding machinery will certainly enhance the rate of farmer's acceptance and adoption of conservation tillage. [28]

Conservation tillage, by reducing soil disturbance, decreases the fallow period and incorporation of cover crops in the rotation cycle and eliminating summer fallowing in arid and semi-arid regions and adopting no till with residue mulching improves soil structure, lowers bulk density and increasing infiltration capacity. [41]

Increased soil density, decreased the volume of macro pores (>30±60 mm) and increased the volume of medium pores (30±0.2 mm), but the volume of small pores (<0.2 mm) only little affected by soil tillage. Increased soil bulk density reduced the air-filled porosity, the air diffusivity and the air permeability as well as the hydraulic conductivity, and sometimes the root development. More plant residues left on or near the soil surface after plough less tillage, which led to lower evapotranspiration and higher content of soil water in the upper (0±10 cm) soil layer. It also led to lower soil temperature and more stable soil aggregates which provided better protection of the soil against erosion. Nutrients and organic matter accumulated near the soil surface after plough less tillage, and in the long run the soil reaction (pH) declined. Nearly all species of earthworms increased in number in plough less tillage. The leaching of nitrogen seemed to increase with more intensive cultivation, particularly when carried out in autumn. [35]

Percentage of water stable aggregates decreases with increased frequency and intensity of tractor-driven operations in savanna zone of Nigeria. Percentage of water stable aggregates was 38 and 57% under NT and only 12 and 25% under CT for aggregates of 2 and <0.5 mm, respectively. Increased soil aggregation was associated with build-up of SOM. [9]

Crop type, tillage system and soil depth had significant effects on soil aggregate stability and bulk density. Soil aggregate stability and bulk density was higher under NT than under mouldboard plough. [38]

Suitability of soils for stubble mulching improves with increasing clay content of the topsoil and for NT with high aggregation [6]. Tillage systems significantly affected soil bulk density in the 0 to 200 cm soil depth. No-tillage bulk densities higher than for the other tillage treatments. [39]

Soil bulk density, cone penetration resistance of the 0–20 cm layer, aggregate stability and water infiltration rate were higher under limited tillage systems than under plow tillage. The improvement of aggregate stability was higher in poorer structured soils. nitrate nitrogen levels were greater in plow tillage. [33]

Sharratt found no differences in porosity (i.e., bulk density) in the upper 50 mm of the soil profile among these tillage treatments, macro pores still may have been more numerous or continuous in no tillage as a result of enhanced fauna activity in soils subject to no tillage. [41]

Manure and mulching with minimum tillage have a greater effect on the water balance of crusted soils and maize emergence. There was increase in steady infiltration rates, amount of soil water stored in the soil and better drainage. The physical effect of mulch was less important in the rehabilitation of crusted soils in the study site when it was incorporated into the soil. Manure and surface mulch with minimum tillage should therefore be taken into account in land management and water conservation in the semi-arid areas. The response of crops to the improved water availability due to manure with minimum and with conventional tillage and surface mulch was very clear. These management practices should be recommended when considering the effectiveness of soil and water management techniques in the study area. [16]

Although steady state infiltration in no tillage exceeded that in intensive tillage, infiltration in no tillage did not exceed that in spring disk or autumn chisel plow. Previous studies reported that infiltration was greater for no tillage as compared with more intensive tillage practices due to greater macro porosity or pore continuity in no tillage. [1]

Conservation tillage has the potential for increasing soil organic matter content and enhancing soil aggregation. Conservation tillage systems can create an aggregated, fertile surface layer that is important from a soil erosion reduction perspective and thus for a sustainable agriculture. [18] and also Conservation tillage, increases the amount of crop residue left in the soil after harvest, thereby reducing soil erosion and increasing organic matter, aggregation, water infiltration, and water holding capacity compared with conventional tillage. [4]

Barber in 1997, a long term tillage experiment established on a Typic Haplustalf in Saavedra 2 years after forest clearing to compare the effects of conventional disc tillage (CT) and three conservation tillage systems, i.e. chisel plough (CP), no tillage (NT) and flexible tillage (FT), on the changes in soil physical properties. Results after the first 4 years (eight cropping seasons) showed that CP caused least soil physical degradation, with compaction being in the order CP < CT < FT < NT, whereas NT caused least chemical degradation, resulting in higher soil organic matter and total N contents. However, the increase in soil degradation over 4 years using mean values from the trial was greater than that among tillage treatments. He concluded that, during the 4 years, in addition to increases in soil compaction, mean infiltration capacity decreased 35–48%, mean equilibrium infiltration rate decreased 77%, average available water capacity decreased 47%, and mean aeration capacity decreased 30%. He told, the overall soil physical degradation of an Alfisol during 4 years of tillage shortly after forest clearing much more pronounced than the differences between conventional disc tillage and the three conservation tillage practices. [2]

No tillage is greater saturated hydraulic conductivity and generally retains more water against gravitational and matric forces than other tillage treatments. Infiltration is greater in autumn chisel plow than other tillage treatments and is presumably suppressed in no tillage by an organic layer overlying mineral soil. Infiltration also enhances by retaining straw on rather than removing straw from the soil surface after harvest. No tillage is not yet a sustainable management practice in world, due to lack of weed control strategies. In addition, the formation of an organic layer in no tillage has important ramifications for the soil hydrological and thermal environment. Therefore, minimum tillage (i.e., autumn chisel plow or spring disk) appears to be a viable management option for maximizing infiltration. [41]

Traditional tillage (TT) method consisted mainly of the use of mouldboard ploughing, and the conservation tillage (CT) characterized by not using mouldboard ploughing, by reduction of the number of tillage operations and leaving the crop residues on the surface as mulch. The soil bulk density in the 0 to 20 cm, hydraulic conductivity of the soil surface layer, at a pressure head of 0 mm layer, resistance to penetration, replenishment of soil water storage is significantly higher in the CT than in the TT treatment, mainly after tillage operations. Conservation tillage applied seems to be highly effective in enhancing soil water recharge and water conservation, particularly in years with much lower than average precipitation[30]

Soil structure affects soil quality and fertility by controlling the establishment and viability of a stable plant cover. Soil aggregation was greater under NT concomitant with greater organic C than under MP. Loss of soil organic C with MP was likely responsible for low aggregate stability. NT significantly increased crop residue accumulation on the soil surface, which enriched soil in labile organic matter, such as polysaccharides that act as binding agents of soil aggregates. [26]

Malhi in 1999, a 5 year study of no-tillage and conventional tillage conducted. He after a 5-year period, determined soil temperature and percent moisture in soil mechanical resistance to penetration. He concluded that, Soil temperatures in the spring at 2.5 or 5.0 cm depth were generally lower under no-tillage than conventional tillage. Percent soil moisture in the surface layer (0–15 cm), on the average of 5 years was 7.2% greater on no-tillage plots than on conventional tillage plots. Mechanical resistance to penetration was consistently greater on no-tillage plots than on conventional tillage plots. [27]

Lei in 2008, showed that at early spring planting, soil temperatures were 0.1°C lower in the stalk-mulching and no-till treatments compare with to the conventional tillage treatment. Soil temperatures were the highest under film mulch in corn grouing season. Soil bulk density in the 0-20 cm layer was lower in the no-tillage treatment compared with conventional tillage. He concluded, soil water content increased under the three conservation tillage in the order stalk-mulching > film-mulching > no-till > conventional tillage. The conclusion is that conservation tillage method can improve soil physical properties and increase crop yield. [35]

Conservation tillage systems resultes in higher soil water contents, lower soil temperatures, more organic matter and more water-stable aggregates near the surface, and higher bulk densities than conventional tillage systems. On sloping, well-drained, low organic matter soils, conservation tillage produced corn yields that were equal or better than yields from conventional tillage. He concluded that, On poorly-drained, low organic matter, poorly structured soils, the soil structure under conservation tillage tended to improve with time as soil organic matter and aggregation increased. [10]

Benjamin et al [5], investigated the effects of three CT treatments: chisel (CH), no-tillage (NT) and till-plant (TP) as compared with conventional modlboard plowing (CN) on a silt loam soil. He hydraulic properties determined in situ. At or near saturation, there was no difference in hydraulic properties for all four tillage treatments. under unsaturated conditions, tillage treatments and soil layering affected hydraulic properties. In situ hydraulic conductivity (K) ranked CH > CN = NT = TP. He concluded that, significantly lower in NT than in the other three treatments. Throughout the 20-day free drainage period for in situ K determination, the effect of layering is exhibited by the mean K values at the 50-cm depth being higher than those at 25 cm. There were negligible treatment-block interaction effects on the hydraulic properties as the soil became drier. **(**Benjamin et al., 1999**).** In dry year the soil water content of conservation tillage is higher than the conventional tillage. [46]

Affect conservation tillage on soil and water conservation

Conservation tillage, a generic term implying all tillage methods that reduce runoff and soil erosion. [25]. Soil and water erosion risk can be used as a reliable indicator of sustainable land management and that using conservation tillage.The key problem in tropical agriculture is the steady decline in soil fertility resulting from soil erosion associated with conventional tillage. Many small-scale farms are severely affected by sheet and rill erosion, and use of the mouldboard plough is a major contributor to both water erosion and wind erosion [13]. In a six-year experiment shallow tillage reduced water erosion by about one half to two thirds in comparison with conventional tillage.

At a wind erosion symposium in 1980, four measures for the control of wind erosion were identified, namely:

1) Mechanical measures – the use of share ploughs or tine implements to create a coarse or cloddy soil surface,
2) Organic measures – cover crops, or the strewing of crop residues or other organic matter on the surface,
3) Stubble cultivation – leaving stubble on the surface,
4) Strip cultivation – leaving the previous season's crop standing, or cutting off high when harvesting and planting between the old rows.

No-tillage, soil erosion reduces 40 and 65% compares to plowing up and down slope, though the planting direction is still up and down the slope. Erosion losses are moderate to insignificant when plowing and planting performed across the slope. Soil and water erosion risk can be used as a reliable indicator of sustainable land management and that using no-tillage or plowing and planting perpendicular to the predominant slope are effective soil conservation practices for this region. [3]

Studies in Zimbabwe and elsewhere have shown that conservation tillage techniques can reduce soil loss to sustainable levels. Vogel, [47] reported that no-till tied ridging resulted in sheet erosion loss of 0.5 t ha^{-1} yr^{-1}, compared with up to 9.5 t ha^{-1} yr^{-1} following a mouldboard plough/hoe system. Mulch ripping also reduced sheet erosion losses. Lower production cost and greater environmental benefits of reduced soil erosion and N leaching and increased C sequestration in no-tillage than in tilled system makes conservation tillage more promising for improving soil quality and sustaining crop production. [32]

The intensive tillage systems accelerated soil erosion, depleted plant-available nutrients and reduced crop productivity. The development of conservation tillage originated from the need to conserve soil moisture and reduce soil erosion. Descriptions of conservation are generally based upon the degree of soil surface residue cover. These effects are better perceived in terms of farmer's land use and soil management techniques, i.e. animal or machine-powered equipment through high and low aptitude land use classification systems [8]**.**

Manure and mulching with minimum tillage have a greater effect on the water balance of crusted soils and water conservation in the semi-arid areas. These management practices should be recommended when considering the effectiveness of soil and water management techniques in the study area that are very important. [16.] Uri in 2000 suggested that the use of conservation tillage does result in less of an adverse impact on the environment from agricultural production than does conventional tillage by reducing surface water runoff, wind erosion and to some extent the enhancement of wildlife habitat. The benefits to be gained from carbon sequestration will depend on the soil remaining undisturbed and further expansion of conservation tillage on highly erodible land will unquestionably result in an increase in social benefits but the expected gains will be modest.

CONCLUSION

New agricultural management systems need to be developed that include consideration and inclusion of economics and economic policies, environmental sustainability, social and political concerns, and new and emerging technology. These systems can ultimately assist land managers to develop new and improved sustainable land use strategies. In some soils and climates, no-till farming can address the emerging issues of the 21st century: global climate change, accelerated soil degradation and desertification, decline in biodiversity, and achieving food security for the expected population of 10 billion in 2050. Replacement of plow tillage by no-till farming, based on crop residue management and use of leguminous cover crops in the rotation cycle, can achieve positive nutrient balance by using manures and other biosolids, and increase C storage in soil and terrestrial ecosystems. The no-till soil and crop residue management system promotes soil carbon storage and long-term sustainable agriculture that provides food, fiber, biofuels, ecosystem services and environmental benefits for all of society.

Higher levels of soil organic C, microbial biomass C and N, inorganic and total N, and extractable P were directly related to surface accumulation of crop residues promoted by conservation tillage management. Removal of surface crop residues can seriously reduce production sustainability in climates where stressful conditions occur.

No-tillage is not yet a sustainable management practice in world, due to lack of weed control strategies. The conclusion is that conservation tillage method can improve soil physical properties and increase crop yield. No-till fallow management increases soil water storage and reduces soil erosion potential. Conservation tillage, increases the amount of crop residue left in the soil after harvest, thereby reducing soil erosion and increasing organic matter, aggregation, water infiltration, and water holding capacity compared with conventional tillage. [4]

The no-tilled soil had increased values of water-soluble C, dehydrogenase, urease and acid phosphatase activities, aggregate stability and glomalin compared to tilled soils, especially in the shallowest (0–5 cm) layer.

Studies have shown that conservation tillage techniques can reduce soil loss to sustainable levels. Principal mechanisms of carbon sequestration with conservation tillage are increase in micro-aggregation and deep placement of SOC in the sub-soil horizons.

Long-term studies have shown that continuous cropping results in decline of SOC, although the rate and magnitude of the decline is climate and soil dependent and can be ameliorated by wise soil management practices. The authors concluded that the low yields during the early years of the experiment could be due to lower soil organic carbon, nitrogen mineralization and higher immobilization of fertilizer. These include manure additions, adequate fertilization, return of crop residues to the soil, and most importantly, conservation tillage coupled with intensive cropping systems, and rotations which include pasture or ley periods.

Acid and alkaline phosphates activities were significantly higher in No-tillage than in conventional tillage treatments. Conservation tillage increases the amount of crop residue left in the soil after harvest, thereby reducing soil erosion and increasing organic matter, aggregation, water infiltration, and water holding capacity compared with conventional tillage.

The results proved that No-tillage with manure and surface mulch are key to improvement of infiltration rates of crusted soils of the research area. Throughout the experimental period, manure and mulch placed on the surface with both minimum and conventional tillage were found to improve the steady infiltration rates of soil.

There are still risks with conservation tillage, including biological risks (increased pest and disease problems), physical risks (changed cycling of nitrogen and increased nutrient requirements due to nutrient immobilization under cold soil temperatures) and chemical risks (increased herbicide use). However, positive soil promoting factors would be expected to increase over time as a result of converting from tillage to no-tillage.

The potential gain in soil organic matter varied among sites depending on soil and environmental variables, tillage and residue practices, initial organic C, rate of C input source of organic material, time of C application, fertilizer use, and cropping systems. Due to changes in the soil physical, chemical, and biological environment, the rates of N transformation in conservation tillage systems differ from those in conventional tillage systems. Under conservation tillage the soil is wetter and more compact in the top 10 cm than under conventional tillage systems.

Conservation tillage systems leave more organic matter , and have a higher microbial biomass, particularly more denitrifies, facultative anaerobes and aerobic microorganisms in the surface (0-7.5 cm) of soils, but have fewer nitrifies and aerobic conditions. The net result is potentially greater rates of immobilization and gentrification of applied N, but slower rates of mineralization and nitrification with more organic matter accumulation and a less oxidative biochemical environment. This is reflected in lower fertilizer N availability to crops under conservation tillage as compared with conventional tillage, at least in the initial years of reduced tillage.

Lal in 2000 proposed that, increased aggregation under NT by an increase in SOM of the 0–20 cm layer. Organic matter depletion could be slowed and reversed through reductions in tillage operations or their elimination. Soil structure could improve with conservation tillage allowing for better water infiltration and retention (less runoff). Infiltration is slower in soils subject to no tillage as compared with conventional tillage practices because soils subject to no tillage can be denser or be less prone to crust disruption. A living, but stable structure at the soil surface is necessary to enhance water infiltration and prevent soil erosion.

There is a negative correlation between dehydrogenase activity and soil aeration condition. So, deficient soil aeration conditions under NT might also explain the high dehydrogenase activity. the higher saturated hydraulic conductivity was apparently caused by greater macro porosity or more preferential flow channels whereas enhanced retention of water was likely caused by an organic layer overlying mineral soil or smaller hydraulic gradients in no tillage. Infiltration was greater in autumn chisel plow than in other tillage practices and appeared to be suppressed in no tillage by the overlying organic layer. The development of this organic layer in the past 14 years, as well as lack of weed control strategies, suggests that continuous no tillage is not yet a sustainable management practice as this layer has important ramifications for the soil hydrological and thermal environment. Therefore, minimum tillage (i.e., autumn chisel plow or spring disk) that incorporates straw left on the soil surface after harvest appears to be a viable management option for maximizing infiltration in world.

Adoption of conservation tillage in the semi-arid tropics (similar to Iran) is consistent with the principles of sustainable agriculture as these minimize deleterious effects on soil However, acceptable methods of assessing sustainability erosion, water quality, biodiversity and is in harmony with natural ecosystems.

Conservation tillage research shown that no-tillage is associated with higher soil bulk density, soil strength, aggregate stability. The more positive aspects such as increased surface organic matter content, plant-available water, high soil hydraulic conductivity and earthworm populations, reduced risks of erosion and sustainability aspects have not been adequately promoted.

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Citation of this article
Ali A, Amirhossein P and Mohammad A. Modeling and analyzing affective factors on dispersion and division of farming lands in paddy workers' view at Sari Township. Bull. Env. Pharmacol. Life Sci., Vol 3 (3) February2014: 283-296