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Modern Tillage Methods in Intensive Cropping Systems & Its Impact on Soil Health: A Review

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Abstract

There is gradual increase in population and as a result of urbanization. The agricultural is land gradually decreasing. To fulfill the growing needs the challenge is to grow more food in lesser area leading to intensive agriculture increasing the cropping intensity by replacing sole and mono cropping with cropping systems. This Results in declining of soil fertility which is the inherent plant nutrient supplying capacity of a soil to match the crop requirement in proper form, quantity and proportion without any deficiency or toxicity problem. It is not simply the quantity of nutrient present in a soil as determined by a particular method. A soil is fertile for a crop if it is healthy physically, chemically and biologically. Currently to maintain soil fertility various management practices have been adopted in modern practices. In this review, we have been discussed about effect of cropping system and modern tillage on soil physical properties, chemical properties, soil fertility, soil microbial activities, soil carbon, crop yield and weed dynamics in terms of different soil indicators for evaluating soil health under different cropping systems and modern tillage methods.

This knowledge will help to ensure sustainability under intensive cropping systems practiced looking at the need of the hour.

Keywords: Fertile Soil, Urbanization, Cropping System, Soil Health, Zero Tillage and Soil Health Indicators

Introduction

Soils are vital to life on earth as it performs many critical functions within ecosystems. It serves as media for growth of plants, provide habitat for animals and organisms that live in the soil, modify the atmosphere by emitting and absorbing gases and dust, absorb and purify water, process recycled nutrients, including carbon, so that plants can use them again, and serve as engineering media for construction of foundations, roadbeds, dams and buildings (FAO and ITPS, 2015). Unfortunately, soil has been and is currently being rapidly degraded at a global scale due to a range of invasion anthropic activities in intensive agriculture. Soil has a fundamental role in crop production (Agabede, 2010). Soil fertility is the capability of soils to support agricultural plant growth and development (IFDC, 2010) ‘soil fertility’, or the capacity of the soil to supply nutrients to a crop (Agegnehu and Amede, 2017). A good yield can be expect if the land is fertile (Ahmed *et al.*, 2016). In this context, soil nutrient contents are considered fertility indicators while crop yield is a measurement of soil fertility. According to (Seyoum,

2016) the change of ecological systems into cultivation land ecosystems has led to soil resource scarcity. Most of the physicochemical characteristics of soil inside the research area are significantly altered by the various land uses. Many soil health indicators among cropping systems have since been discussed and developed, including soil microbial composition and enzyme activities (Ozlu *et al.*, 2019; Ve Verka *et al.*, 2019) C:N ratio (Byrnes *et al.*, 2018; Gannett *et al.*, 2019), soil biological properties, including mineralizable (Hurisso *et al.*, 2018; Obrycki *et al.*, 2018) and permanganate oxidizable carbon (Thomas *et al.*, 2019; Van Es and Karlen, 2019),soil physical properties such as water holding capacity, water-stable aggregation, surface and subsurface penetration resistance (Van Es and Karlen, 2019); and soil chemical properties such as alkaline phosphatage activity involved in P cycle (Bhandari *et al.*, 2018) and extractable K, Mg, Fe, Mn, Zn content (Thomas *et al.*, 2019) . The most recent development on soil health assessments include the Cornell comprehensive assessment of soil health-CASH (Gholoubi *et al.*, 2018; Schindelbeck *et al.*, 2008) and 'Haney soil health test-HSHT' (Chu *et al.*, 2019), which quantify soil health under different cropping systems by focusing on soil biology, such as plant-available nutrients, soil respiration, and bioavailable C and N.

Cropping system may be defined as sequence or order in which crops are grown on a piece of land over a fix period of time.Cropping systems can be considered soil improving if they result in an improved soil quality, *i.e.*, in a durable increased ability of the soil to fulfill its functions, including food and biomass production, buffering and filtering capacity and provision of other ecosystem services. Soil improving cropping systems prevent and/or mitigate soil degradation, and contribute to restoring and improving degraded soils. Soil health has also become of great interest in developing areas, where the extensive production system has been intensified (Sinha *et al.*, 2013). By increasing human population and extra use of lands and recognition of importance of sustainability in agricultural practices, hypothesis goes to minimal impact process such as no-till system which improves soil quality and crop yield. Zero tillage had significantly higher concentrations of soil ph, organic C, N, P, K, Ca, and Mg for surface soil (0-15 cm/6) (Agabede, 2010). Some benefits of conservation tillage system such as no tillage and mulch till (Reddy *et al.*, 2004 are increasing microbial biomass (Helgason *et al.*, 2010), improving soil carbon (Lal *et al.*, 2003), increasing N mineralization (Spargo *et al.*, 2011).Cropping systems, a crucial part of an agricultural system, describe the cropping patterns used on a farm and how they interact with other agricultural enterprises, agricultural resources and technology available to them. It is widely recognized that the activity of mycorrhizal fungi can improve soil quality. Cropping systems promote soil mycorrhizal fungi inoculation (Bharadwaj and Tandon, 1981). Changes in the chemical and physical characteristics of soil brought in by various tillage techniques can have an impact on elements directly related to biotic actions in the soil, including soil moisture, organic matter, temperature and ventilation, as well as the degree of interaction between soil organic matter and nutrients.

The main aim of this review is the importance of cropping system to maintain soil fertility in terms of improving crop yield and the impact of conventional cropping system on soil health. Changes in soil chemical and physical characteristics caused by various tillage techniques can affect elements directly related to soil biotic actions, including soil moisture, organic matter, temperature and ventilation, as well as the degree of interaction between the soil organic matter and nutrients (Torabian *et al.*, 2019 (Chary *et al.*, 2019) experimented with the impact of various cropping sequences and different nutrient management on the soil quality indices. They revealed the results as the cropping sequences with cotton-cotton showed the higher performance with 1.06 and lower in sesame-cotton & sesame-groundnut with 0.89. Available Nitrogen is maximum in sole organic sources with 197.9 kg N ha-1, Cotton-groundnut cropping sequence provided the highest available phosphorus at the rate of 24.72 kg P ha-1 and maximum available potassium is found in the cotton-cotton cropping sequence with 449.1 kg K ha-1 in comparison to control, INM, RDF and sole organic nutrients. Since conservation tillage improves the physical conditions of the soil (Botta *et al.*, 2022). The cropping system eliminates the deficiency of any nutrients element in the soil (Shankar *et al.*, 2021).

Indicators for evaluating soil health in different cropping systems

In any case it's important to include physical, chemical and biological properties when assessing soil health (Bunemann *et al.*, 2018). Soil biological properties mainly microbial properties are becoming increasingly used owing to their ecological relevance, quick response, sensitivity and capacity to integrate responses from various environmental factors (Barrutia *et al.*, 2011; Galende *et al.*, 2014; Mijangos *et al.*, 2006). Traditionally, physiochemical properties like texture, depth, bulk density, water holding capacity, porosity, pH, EC, organic matter, cation exchange capacity, nutrient content have been used as soil health indicators. Soil parameters that provide information on the biomass, activity and diversity of soil microbes are being used as a bio indicators of soil health (Epelde *et al.*, 2010; Mijangos *et al.*, 2006; Pardo *et al.*, 2014), which is not surprising as soil microbes that plays a key role in many critical soil processes, such as decomposition of organic matter and the recycling of nutrients related to primary biogeochemical cycles.

Many other taxonomic groups of soil biota such as soil micro or earthworms, mites and nematodes can be used as bio-indicators of soil health (Bunemann *et al.*, 2018). A drawback to all of biological indicators of soil health is the lack of standardized and harmonized information relative to soil physico-chemical indicators resulting in a lack of suitable references value which hinders the interpretation of soil biological parameters. Soil health indicators can be used as individual properties or integrated into indices. Many soil health indices (simple and complex multi-parametric indices) have been proposed in the literature (Klimkowicz-pawlas *et al.*, 2019; Velasquez *et al.*, 2007).

1. Effect of Cropping system and Modern tillage on soil physical properties –

Soil physical properties like bulk density, soil aggregates stability, water retention capacity are some of the quality parameters of soil that affect soil fertility. There are many reports of increase in bulk density after intensive cropping such as in rice-potato-rice (Sadannandan and Mahapatra, 1972), rice-rice and rice-wheat (Mahapatra *et al.*, 1985). However, incorporation of FYM at 10-15 t ha-1 (along with NPK) for 7-13 years generally results in a slight decrease in bulk density in almost all soil types indicating improvement in soil physical properties (Nambiar, 1994 a).

Hydraulic conductivity is defined as the parameter that represents the ability of soil to conduct water; proportionality factor in Darcy's Law. It is equivalent to the flux of water per unit gradient of hydraulic potential (Soil Science Society of America, 2008). Application of organic matter improves hydraulic conductivity in most of the Indian soil (Nambiar, 1994).

Aggregate stability is defined as the proportion of aggregates in soil that do not easily crumble, disintegrate, or slake.Percentage of water stable aggregate was found to be higher in *Pennicetum pedicellatum* grass (Sinha and Chaterjee, 1966). However water stable aggregate content in most of Indian soils is not more than 10-15%. (Mahapatra *et al.*, 1985) as puddling broke down the water stable aggregates. Soil organic matter determines water holding capacity of soil. Bullock (1992) found out that by increasing water holding capacity of soil crop rotation didn't have any effect on crop yield. Water retention in soil is regulated by increased soil aggregation.Crop rotation including grasses is beneficial for aggregate stability and it forms favourable soil structure (Robinson *et al.,* 1994) .

2. Effect of Cropping system and Modern tillage on soil Chemical properties

Soil pH- Soil pH is affected when there is imbalance in anions and cations. By growing same crop as well as by rotational cropping system there was no change in soil pH. However, continuous cultivation of crops using ammonium sulphate lowered soil pH (Kanwar and Prihar, 1962). Highest increase in pH was noticed in rice-jute-rice cropping system, the next being groundnut-jute-rice cropping system (Sadanandan and Mahapatra, 1972) after completion of two cycles. A two year conventional rotation trial was conducted at university of California and found that the pH values of the surface soil were 6.7 and 6.5 for the organic and the low input cropping system, respectively, and were significantly greater than the corresponding soil pH value 6.3 (Poudal et al, 2001). However, Timsina *et al.* (2001) reported that there was slight decrease in pH after three years of rice-wheat cropping system in Bangladesh. This indicates differential response of cropping systems on soil pH. Soil environment and type of crops grown under different cropping systems have significant role in relation to soil pH.

Soil organic matter- After green revolution as animals were replaced by machines the use of organic matter applied in the form of FYM is now decreasing in the rice-wheat systems. (Fujisaka *et al.*, 1994). Dhiman *et al.*, 2000, reported that there was slight bulid up in SOM with green manure-rice-wheat and rice-potato-sunflower cropping systems. According to Yadav *et al.,* 2000, rice-wheat cropping system was responsible for degradation of SOM and reduced nutrient supplying capacity of soils with higher initial SOM content. Similar report was identified by Timsina *et al.,* in 2001, from Bangladesh where, organic carbon decreased after 5years of rice-wheat cropping system.

3. Effect of Cropping system and Modern tillage on Soil fertility

Nitrogen -Nitrogen plays important role in crop cycle and is limiting factor in crop production system. Clark *et al.*, 1998; found that major portion of nitrogen applied to a crop is removed as harvested output and rest of the nitrogen may be stored in soil as organic matter and part of it may be lost as leaching, denitrification and ammonia volatilization. According to (Honeycutt, 1999; Kolberg *et al.,* 1999; and nitrogen stored in soils become available for future crop use via N mineralization which increases crop productivity and profitability over long run. Ghosh and Malik (1999) noted that by application of higher dose of fertilizer, total soil nitrogen increased considerably over their initial in potato crop after completion of two years of potato-sesame-rice cropping system at Sriniketan. Mukhopadhyaya and Roy (2000),found out the same result of improvement of soil nitrogen in 4cropping system *i.e.,* potato-mung-jute, potato-maize-rice, potato-jute-rice and wheat-jute-rice cropping system during their study at BCKV, Kalyani, west Bengal. loss of nitrogen was seen in conventional system with high synthetic fertiliser use and the loss was much higher than organic and low input system (Poudel *et al.* 2001), Timsina et al. 2001reported that soil nitrogen was significantly increased at all depths after three years of rice-wheat cropping system in Bangladesh. Productivity of a system is determined by the indigenous nutrient supplying capacity of soil. In rice-rice cropping system organic matter releases soil nitrogen and it even increases over time but with lower availability. Nitrogen supplying capacity of low land rice soils ranges from 30-105kg/ha as reported by Singh, 1995 at IRRI. Dobermann, 1998, reported that nitrogen balance in intensive cropping system is estimated by measuring nutrient outputs from crop removal, leaching, runoff and seepage of inputs from fertilizer, recycled straw, irrigation water, rainfall, sedimentation and capillary rise. These are most important indexes of long term sustainability of a cropping system.

Phosphorus-Biswas et al, 1977,found out that in multiple cropping systems, after harvest available P was improved over initial P status after two cycles of crop rotation. Singh and Jones (1976)found out that rice straw when incorporated in soil P sorptivity decreases and its availability become increases. Indigenous supply of Phosphorus was 6-8kg/ha for wheat and 15-18kg/ha for rice in rice-wheat cropping systems (Singh et al, 2000). Bharadwaj and tondon, 1981 reported that there was P build up under cropping system that contains potato. Ghosh and malik (1999) also noticed there was considerable increase in available p over its initial soil content after 2 years of potato-sesame-rice cropping systems due to use of high fertilizer in potato. The available p status of soil was reduced to 50% of its initial soil content *i.e.,* 24kg/ha in control plots but maintained its status with 60kg/ha in pearl millet-wheat, guar-wheat and jowar-wheat cropping systems. (Grewal et al, 2000).Phosphorus deficiency occurs widely in lowland soils that have high native P-fixing capacity, acid soils in south China, Indonesia, acid sulphate soils in Mekong delta, alkaline soils in Bangaladesh, Pakistan.

Potassium-Saha et al, 2000,found out that status of increasing K ranging from 23.62-43.28kg/ha in jute-rice-wheat cropping system. The reason might be due to release of substantial amount of K from non-exchangeable sources. The K nutrition of rice-wheat cropping system grown on the soils of indo-gangetic plain is not assured however despite after relative large total K content because many heavy textured alluvial flood plain soils of Nepal, Northern and Eastern India and Bangaladesh contain vermiculite, illite or other K fixing minerals (Dobermann et al.; 1998) perhaps it was due to unfavourable ratios of K to other cations (Ca, Mg, Fe) in the soils as has been cited by Dobermann et al.;1996 for pantnagar soil. Grewal et al.,2000 reported that after 18 years of continuous cultivation of pearl millet wheat, guar wheat and jowar wheat in hisar, the soil K level decreased from the initial level of 754 kg/ha to 90kg/ha to every crop. Nambiar in 1994, reviewed long term experiment trials and found out that exchangeable K status in sodic soil at karnal Haryana declined with rice-wheat cropping systems.

Micro-nutrients-Sulphur is now recognized as the 4th major plant nutrient along with NPK, Sulphur plays an important role in the productivity of different cropping systems which contains oilseeds in particular. Importance of sulphur is highest in cruciferea and liliaceae and lowest in small grains. Nambiar in 1995 reported that continuous application of high analysis fertilizers over the year resulted in significant reduction in crop yield, especially due to withdrawl of much of available sulphur. The deficiency of S was reported in Bangladesh, India, Indonesia, Myanmar, Pakistan, Phillipines, Srilanka and Thiland and more recently also found in rice fields of Yunnan province, China by Blair et al, 1978; [25] Deng et al, 1989.Currently, the number of districts with sulfur deficient soils in India is more than 200 (Tandon and Messick, 2002).Shukla and Lal, 2002 conducted rice and coarse cereal based cropping systems experiment in arid, semi-arid, humid and coastal ecosystems and found that the deficiency of Sulphur and Zinc present in the soil is responsible for the slow growth of food grains. Application of 25kg/ha of sulphur enhanced the productivity of rice-rice and rice-wheat systems over control by 8.99%, 18.05 and 8.49 % in coastal, semiarid and humid ecosystems respectively. There was increase in yield in rice-mustard cropping systems by application of sulphur at Murshidabad (west bengal) (Sen *et al.*, 2002) soil micronutrients like B, Co, Cl, Cu, Fe, Mn, Mo and Zn are a complex function of parent material and pedogenic process. The reason behind deficiency/ micronutrient problems in soils, plants and human related to soil parent material and age of the soil and the problems are intrinsic and regional in nature

(Cakmak *et al.*, 1999; White and Zososki, 1999).Rice suffers from Fe deficiency in the coarse textured soil of Punjab due to low Fe content and difficulty in maintaining standing water (Nayer and Chibba, 2000).The development of high yielding and hybrid rice-wheat cropping system further exacerbate the problem, not only that larger amount are removed but because the large amount of NPK Fertilisers change micro-nutrient availability. This situation contrasts with the traditional system in which adequate replacement relative to low extraction is achieved with FYM and other organic nutrient sources. Availability of micro-nutrient varies with soil type and also as the rice –wheat system moves through its aerobic and anaerobic phases. The reduction and solubilisation of Fe and Mn under flooding render these nutrients more available to rice than the corresponding oxidized forms to wheat (Navar and Chibba, 2000). Zinc is available in aerobic than anaerobic soils (Yoshida, 1998) and hence is commonly deficient in rice lands by Neue *et al.*, 1998 [86] and rice –wheat systems of indo-gangetic-plain (Abrol et al, 2000). The availability of Mo and B is related to the crystalinity of Fe+++ oxides such that the reduction oxidation cycles may gradually reduce their availability by Willet, 1983.However, the availability of Cu is independent of the oxidation-reduction process. It is strongly complexed by organic compounds that may become unavailable to both rice and wheat on peat soils. Many alluvial soil of Indo-gangetic plain are calcareous and at high pH, supplies of available Zn, Cu and Mn may be in adequate for both rice and wheat. Sakal during 2000 reported that rice-wheat cropping for 10 years on a calcareous soil in Bihar, India decreased Zn and Mn concentration but increased those of Fe and Cu. Shukla and Lal 2002 reported that application of Zn increased the productivity of rice-rice cropping system in semi-arid ecosystem and in rice-wheat and pearl millet-mustard cropping systems at humid eco-system.In acid soils, Mo availability increases with pH following inundation and their decreases with pH following drying in alkaline soils however, ph shifts are reversed on flooding and drying. Those reactions are relevance to rice-wheat systems particularly on acid soils where Mo availability is small. In rice-wheat cropping systems, levels of micro-nutrient generally increase due to use of green manures (Singh *et al.*, 1992, Nayar and Chibba, 2000; Verma and Sharma., 2000).

4. Effect of Cropping system and Modern tillage on Soil microbial activities

As the primary organisms responsible for bio-geochemical cycling, soil microbial communities catalyze a range of processes such as nutrient cycling, which are important to the productivity and sustainability of soil ecosystems (Bissette *et al.*, 2013). Soil microbial biomass is the living part of organic matter. It comprises <10% of soil organic matter, however it performs important functions for crop production inside an ecosystem (Salinas *et al.*, 2002). Soil quality is largely governed by SOM, which is dynamic and responds effectively to changes in management practices. The level of soil organic matter is determined by biological, chemical and physical properties of the soil that control microbial activity (Cole *et al.*, 1987). In this way soil enzymatic activity and soil microbial biomass have been shown to be sensitive indicators between different sustainable cropping systems (Kennedy and Papendick., 1995). Microbial biomass often responds quickly to changes in soil management practices and is known to be an indicator of soil quality (Roldan *et al.*, 2003). Conservation tillage especially no-till can improve the substrate availability and the microbial nutrient (Roldan *et al.*, 2003). Drijber *et al.*, 2000 reported that cropped site always showed higher microbial mass than fallowed sites in a wheat system. In general, the long term effects of soil management practices on the size and activity of soil microbial biomass have been found to be closely related to changes in total soil organic matter content (Haynes and Beare., 1996).The total organic C and available P showed significant correlation with microbial biomass C and

Microbial biomass P respectively while total N showed significant correlation with microbial N (Roldan *et al.*, 2003). Soil microbial properties, such as microbial biomass and soil enzymes, have been used to predict the biological status of soil and the effect of agricultural management in relation to soil quality (Eivazi., *et al.,* 2003). Wright *et al.,* 2005 found that microbial count to be greatest under no-till management but only in the surface 2.5cm with little tillage effects to 20cm. The conservation tillage reduced C concentrations resulting from oxidation of labile soil organic matter due to tillage (Purakayastha *et al.*, 2008). The content of active carbon and microbial biomass carbon in the long term trial and contents of active carbon in the short term trial were higher foe conservation tillage than traditional tillage at 0-5cm depth for both sampling periods Melero *et al.,* 2009). In a brazilian oxisols there was a comsistent increase in biological activity and N mineralization with no-till management (Green *et al.,* 2007). Similar increases with depth have been observed in Arid wheat based systems where total soil N increased by 38-68% (Dou and Hons, 2006). Interestingly the conservation tillage soil mineralized as much N as the no-till systems but had less total soil nitrogen than no-till (Purakayastha *et al.,* 2008).

5. Effect of Cropping system and modern tillage on soil carbon-It has been well established that agricultural soils can be a sink for good carbon through the formation of soil organic matter (West and Post, 2002). Soil organic matter is an important indicator for soil fertility. it is strongly affected by tillages as well as temperature, moisture, soil texture, plant residue quantity and quality (Berner *et al.*, 2008).while conventional tillage in the long run doses alteration in soil structure and increases the loss of soil carbon, the magnitude of these effects is a function of the intensity of tillage, the frequency of tillage and the quantity and quality of fertilizers and organic waste returned to the soil. Conservation tillage has the potential for converting many soils from sources of atmospheric carbon to carbon sinks (Rasmussen and Collins, 1991). Conservation tillage may increase the amount of organic carbon in the soil by providing an environment where fungal decomposition is greater than the bacterial decomposition. Fungal decomposition results in more recalcitrant decomposition products than bacterial decomposition (Holland and Coleman, 1987).An increase in conservation tillage has two identifiable effects with respect to carbon emissions. First no tillage results in an increase in carbon retention in the soil because less organic matter is lost to oxidation from mixing of the soil and soil temperature tend to be lower, which slows oxidation from from mixing of the soil. The lower soil temperature slows decomposition. Secondly conservation tillage is more energy efficient than convention tillage, as fewer machinery operations are required less fossil fuel is used thus carbon emissions are reduced. The amount and kind of crop residues have an effect on organic carbon levels in the soil (Uria *et al.,* 1998). Soil organic matter plays a crucial role in all aspects of soil quality (soil structure, soil-water relations, chemical fertility and biodiversity) and is therefore a key indicator for integrated soil quality assessment (Carter, 2002).In general the soil organic carbon recalcitrance decreases under No-till systems indicating that crop residues added are only partially decomposed, exceed microbial metabolic rate and form less humified soil organic carbon fractions (Bayer *et al.*, 2000; Tivet *et al.*, 2013). Several studies (i.e Ball *et al.*, 1996; Beare et al, 1997), showed an enrichment of microbially derived carbohydrates under no-till versus conservation tillage. Management practices such as no-tillage have been frequently recognized for their effect on soil organic carbon storage (A Ivsro-fuentes *et al.*, 2009). In addition, incorporation of forage species into crop rotations seems to increase hot water extractable organic carbon in the 0-5cm depth, probably due to higher root inputs and the stimulation of microbial activity that follows (Liehard *et al.*, 2013). The 10years effect of management on soil organic carbon are complex and vary with soil conditions such as soil texture, climate, cropping system and kind of crop residue as well as with the management of itself (Al-kaisi *et al.*, 2005; Munoz *et al.*, 2007).compared with conservation tillage, sub soiling tillage and no tillage had significantly higher soil organic carbon concentration (Awale *et al.*, 2013). Generally the soil organic matters in all treatments were generally higher under conservation than under conventional tillage (Vogeler *et al.*, 2009). No tillage generally increase the sequestration of soil carbon but this increase might not be apparent for approximately 5-10years (West and Post., 2002; Franzluebbers and Arshad., 1996). However, Franzluebbers and Arshad, 1996 noted that there was little or no detectable increase in soil organic carbon content in the first 2-5years after implementing conservation tillage. Weil *et al.*, 2003 found active carbon to be more sensitive indicators of soil management than total organic carbon. The increase in total organic carbon under conservation tillage in the long-term has been observed by Melero *et al.*, 2008.In reduced tillage or no tillage systems, carbon sequestration takes 25-30 years to reach a new steady state (Alvarez, 2005). Twenty years after conversion from conventional tillage to no tillage, soils contained 16% more organic carbon under a temperate wet climate and 10% more under a temperate dry climate (Berner et al, 2008). According to Mikha and Rice in 2004, no tillage greatly enhances carbon accumulation within soil aggregates and increased tillage intensity in many conventional tillage systems; such as plowing, chisel plowing. Tillage can be significantly modified by edaphic factors and therefore influence the rate of carbon mineralization (Huggins *et al.*, 2007;Curtin *et al.*, 2012). Soil organic carbon was greater under no tillage than under conventional tillage and reduced tillage (A lvaro-Fuentes *et al.*, 2009). CT significantly increased P as did manure addition. However, with manure, K was significantly increased in all tillage treatments (Anwar *et al.*, 2007).

6. Effect of Cropping system and Modern tillage on Crop yield-

The main goal of tillage is to provide optimum condition for the growth of seedlings, germination of seeds and the best possible yields. Crop yield is dependent on various factors such as soil conditions, topography, and weather, biological and human activities that all are highly variable. A current trend in rice-wheat cropping system (RWCS) is the excessive use of tillage implements to obtain a good tilth. Management practices such as tillage, fertilizers, and pesticides result in degradation of natural resources and low grain yield (Chhokar *et al.*, 2007). Research results showed that conventional tillage practices declined soil structure and stability over years due to depletion of soil organic matter, which is already low in the soils of northwestern Pakistan affecting crop yield (Fan *et al.*, 2005). The present wheat yield is much lower than its genetic potential. Wheat sowing in Pakistan is usually delayed when it is sown after the harvest of valuable rice. Conventional agriculture is serious threat to sustainability of RWCS and hazardous to environment (Holland *et al.*, 2004).

7. Effect of Cropping system and Modern tillage on weed dynamics-

Weed management represents a major challenge to adopting conservation tillage. Tillage influences weed life cycle processes by directly destroying seedlings, redistributing seeds vertically in the soil profile and altering soil properties that influence seed persistence, dormancy, germination and seedling survival. Therefore shift in weed community population dynamics frequently occur when any type of conservation tillage is adopted, including zero tillage. Different crop rotations indirectly affect weed populations through the effects of tillage, as the timing and frequency of tillage varies by crop species

(Légère *et al.*, 2011; Smith, 2006). Weed species that are phonologically synchronous with a particular crop species tend to survive and proliferate with that crop (Anderson, 2005). (Smith, 2006) concluded from a three-year study that spring tillage produced weed communities dominated by spring-emerging annual grasses and C4 grasses, while fall tillage favored more spring-emerging annual and C3 grasses. Plant crops with different phonologies, such as winter wheat vs. maize, helps to disrupt crop–weed life cycle synchronies (Anderson, 2010), although (Anderson, 2005) reported that alternating two years of a warm season crop with two years of a cool season crop reduce weeds more than alternating cool and warm season crops on a yearly basis in ZT system managed conventionally. Organic conservation tillage systems have relied heavily on high-residue cover crops to suppress emerging weeds. Cover crops suppress weeds by providing a physical barrier, but they also block light and slow soil thermal cycling, both of which serve as germination signals for many species of small-seeded annual weeds (Mischler *et al.*, 2010; Altieri *et al.*, 2011). Although cover crops primarily inhibit weed growth through physical suppression imposed by surface residues, these crops can also influence weed communities through allelopathy, alteration of nutrient cycles, and improvement of the decomposition of weed seeds (Conklin et al 2002; Creamer et a., 1996). It has long been believed that rye produces allelopathic compounds (Barnes and Putnam, 1983; Barnes and Putnam, 1986). The allelopathic phytotoxic effects produced by rye residues are believed to be mainly due to benzoxazizone compounds. The biosynthesis of these compounds is greater in younger tissues and varies depending on rye cultivars and environmental factors (Schulz *et al.*, 2013).

Conclusion

Diversification of cropping systems an innovative movement with farmer friendly approach is necessary to get higher yield and economic returns and to maintain soil health, preserves environmental resources and to meet daily requirement of human and animal. Thus not only the number of crops but type of crops included in the cropping sequences is also important. In this approaches, resources are not only utilized efficiently but also ensure on a farm and their interactions with farm resources. Different cropping systems have various residual effects on different soils.The sensitivity of soil indicators can provide information on the dynamic nature of soil properties under field conditions. Significant achievements including refine content of soil health and the development of new evaluation standard for soil health and quality by combining various soil health indicators such as soil physic-chemical properties, soil microbial status and cropping practices into indices in agro-ecosystems, can be used to evaluate and guide soil and crop management decisions. Although soil biology has been established and recognized as an important component of soil science for centuries, new research strategies and commercial investments related to the impact of anthropogenic activities on soil health and quality are raising questions now-a-day. There is opportunity for further refinement to assess the soil quality parameters based on crop productivity under different soil types.

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