

## Effect of Cropping Sequence on Agricultural Crops: Implications for Productivity and Utilization of Natural Resources

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### Abstract

Offensive land uses system with continuous growing of similar crops on the same land largely affect soil physical condition, crop development and had big concerns on long term adverse effects of environmental pollution. The choice of sequence highly based on agricultural system, finance and environmental condition. Conventional monoculture agricultural systems can reduce the soil organic matter contents and structures. The accumulation of crop residues with frequent inclusion of pulse crops in a rotation is vital to improve the biochemical and physical properties of the soil via increasing the labile of organic matter. Surface residue of crops is one of the most effective erosion control measures and increase soil moisture content. Different crops have dissimilar growth and development periods thus, one crop may provide protection from erosive forces during a period of the year and the other may not. Besides, crop rotation combines with different management practices are essential to improve the physical, chemical, biological properties of the soil and thereby control erosion and to maximize crop yield by maintain soil moisture and control disease and pests infestation.

**Keywords:** Crop rotation; Cropping sequence; Soil moisture; Soil conservation

### Introduction

Cropping sequences is a rotation system approach in crop production that enabling the available natural resources to be preserved and more efficiently utilized. It is the growing of the succession of crops in time on one field in particular time [1]. With regard to plant growth and soil fertility, cropping designs containing more than one crop are normally built up by elements of crop sequences with a beneficial crop and an exploiting one [2]. Intensive land uses with continuous growing of similar crops significantly affect soil health, crop growth and has raised concerns about the potential have long term adverse effects on environmental pollution. To amend this situation, use of intensive cropping system like sequencing crops in defined patterns based on scientific knowledge is extremely important [3].

### Experimental

Currently, growers cultivate their crops with definite kind of succession of crops to optimize cropping system to benefits from the system. The choice of sequence is primarily depends on a management of the crop, financial and agricultural or environmental factors. The primary goals of finance and agriculture or environment are to increase profit and yield increment from a particular sequence of crops, respectively [1].

Different reports revealed that, cropping sequences in a particular location may be influenced by agro-ecological conditions; such as rainfall, topography, soil type, fertility status, disease and pests. In

addition to this, cropping sequences is possibly prejudiced by socio-economic and environmental conditions. In Iran wheat seed yield was increased up to 37% in wheat-wheat-wheat-rape seed-wheat compared with wheat monoculture [4]. In the same manner, Dogan et al., [5] concluded that crop rotation is more advantages in Turkey than monocultures experiments in sunflower-wheat-pea-common vetch rotation. In Ethiopia, barley grain yield in crop rotations with dicotyledonous crops exceeded that in cereal rotations by 62% and 46% in the second and third seasons; the grain yield of barley in two years rotational sequences is higher by 31% than three years rotational sequences [6]. Inclusion of precursor crops markedly increased maize yield as compared to mono crops at Bako in Western Ethiopia. The highest grain yield was obtained when haricot beans and Niger seed were the precursor crops. Haricot bean, Niger seed and Soybean was recommended to be used as precursor crops with either 12 t ha<sup>-1</sup> of farm yard manure (FYM) or 89/35 kg ha<sup>-1</sup> NP<sub>2</sub>O<sub>5</sub> [7]. Despite the fact that, Niger seed did not fix atmospheric nitrogen, its effects on maize yield was significantly better than soybean. This might probably improve better physical and chemical properties of the soil and even may improve the residual availability of the phosphorus that increase grain filling of main crop [8]. Cropping sequence improve crop yield and soil fertility by different ways. For instance, the benefits of rotating cereals with legume in crop rotations are fix nitrogen by the legume, interruption of weed, disease and insect cycles by dicotyledonous crops, crop diversification, and improvement in soil status and a reduction in rainfall, runoff and erosion [9]. Proper sequencing of crops, which can accentuate positive synergistic interactions among crops, increase precipitation use efficiency and reduce potential pest problems is an important component of sustainable cropping systems [10]. In soybean maize cropping sequence, maize yield increases since the soybeans' ability to fix atmospheric nitrogen and increase the soil

fertility particularly soil nitrogen and consequently enhance the productivity of the succeeding cereal crops [11]. In most cases the yields of cultivated crops are higher in crop rotation than a monoculture under identical conditions is explained by the rotation effect [12]. Therefore, this review included some findings on the effect of cropping sequence on agricultural crops through efficient utilization of natural resources in Ethiopia.

## Results and Discussion

### Effects of cropping sequence on soil physical, chemical and biological properties

**Effect on soil physical properties:** Conventional monoculture agricultural systems can reduce the quality of soils by loss of organic matter, texture and structures due to regular disturbance from tillage practices. Reicosky et al., [13] reported that, the impact of tillage on soil organic matter is varying by soil type, cropping systems, residue management, and climate. Cropping sequence affects crop performance not only grown on lands prepared in conventional land preparation but also it affects crops grown under no till systems. Different crop sequences under no till affect the quantity, quality and permanence of crop residues, amplitude of fallow periods, and distribution and type of root systems [14,15]. The accumulation of crop residues with frequent inclusion of pulse crops in a rotation is revealed to improve the biochemical and physical properties of the soil by increasing the level of organic matter [16,17].

Low aggregate stability and high dispersive soil with low organic matter contents allowed the development of a dense and thick crust for all soil aggregate sizes [18]. Long term rotations which include forages, manure or straw applications often result in lower bulk densities (higher porosities) than row crop rotations. In rotations dominated by small grains, changes in bulk density caused by forage cropping, cereal residue inputs or manure additions are less consistent. Aggregation is a useful measure of soil tilt, since the size and strength of the aggregates determine the extent and stability of the pore space [19]. Usually organic matter of the soil is a major cementing agent in temperate soils and plays a prevailing role in the formation and stability of aggregates. Crop rotations which include sod crops or legume grass cycles increase the stability of aggregates [20]. Dormaar [21] concluded that continuous wheat cropping resulted in 30% more water stable aggregates than the two or three year fallow wheat rotations, thus water infiltration into the soil is largely prejudiced by the amount,

continuity and stability of soil pore space. Soil aggregates which disperse upon wetting will cause a reduction in porosity and water infiltration.

**Effect on soil chemical properties:** Various authors stated that cropping sequences has impact on soil physical, chemical and biological properties and one of the benefits of cropping sequence is to make efficient use of plant nutrients in the soil. Most pulse crops are essential to ensuing non-legume in providing nitrogen and make it favourable growing condition and this might be reducing chemical fertilizer requirements of succeeding non-leguminous crops [14,22]. Most of the time cropping systems that include legumes have the potential for contributing N to following crops and may moderate NO<sub>3</sub> levels in the soil to avoid potential for NO<sub>3</sub> leaching [23]. It is estimated that under field experimental conditions grain legumes can fix more than 60% of their nitrogen requirement depending on the legume host [19,24].

Maize planted following faba bean forerunner crop without rhizobium inoculation was produced significantly higher mean grain yield at full recommended nitrogen fertilizer [25]. Redox potential is soil characteristic which is affected by many of the chemical, physical and biological processes in the soil and it is considered as useful characteristics in arable soil. The influence of different sequences of crop rotation on Redox potential and nitrification in the topsoil and the subsoil of a Luvic Chernozem were investigated. Redox potential was higher in the topsoil (0-30 cm) than subsoil (30-60 cm); the highest Redox potential and lowest potential nitrification was under the cropping sequence of barley preceded by sugar beet and the lowest Redox potential and highest potential nitrification was found under wheat after alfalfa Bohrerova et al., [26]. The trial was conducted to compare continuous cropping of cereals, oil seeds and legume pulse crops in Australia. Total soil nitrogen at depth at 0.5-1 m was significantly greater after 2 years of pastures than under continuous cropping. Grain yield was increased by 0.33-.55 t/ha in canola and 1 t/ha in wheat, grain protein raised by 0.7-2.3% in canola and 1.3% in wheat (Table 1). [27]. Therefore, total soil nitrogen at depth 0.5-1 m was higher after two years of pastures than under continuous cropping and also grain yield was increased by 0.33-55 t/ha in canola and 1 t/ha in wheat, grain protein raised by 0.7-2.3% in canola and 1.3% in wheat [27]. Cropping sequence study in western Canada also suggests that continuous canola production could be unsustainable over the long-term and yield declined with continuous canola production [28].

Treatments	Crop/pasture	Grain yield (Mg/ha)	Protein (%)	Crop/pasture	Grain yield (Mg/h)	Protein (%)
1	Wheat-N	3.66	9	Canola <sup>-N</sup>	0.41	16.6
	Wheat+N	4.05	10.4	Canola <sup>+N</sup>	1.02	16.7
2	Field pea	3.89		Wheat <sup>-N</sup>	5.04	9.8
	Field pea	3.89		Wheat <sup>+N</sup>	5.49	9.9
3	Canola <sup>-N</sup>	2.13	15.8	Wheat <sup>-N</sup>	4.09	6.9
	Canola <sup>+N</sup>	2.68	18.1	Wheat <sup>+N</sup>	5.09	8.2
4	Pasture	-		Canola <sup>-N</sup>	1.02	18.9
	Pasture	-		Canola <sup>+N</sup>	1.35	19.6

LSD (0.05)	Wheat	0.1	1.2	-	0.37	1.4
	Canola	0.35	0.9	-	0.32	1.1

**Table 1:** Yields of wheat and canola affected by the rotation with cereals, oil seeds, legume pulse and pasture. Note: N<sup>+</sup>=with fertilizer, N<sup>-</sup>=Without fertilizer. Source: McCallum et al., 2000.

Research conducted by Getachew et al., [29] indicated that cropping sequence affects nitrogen need, productivity and quality of malting barley in the highland part of Ethiopia, and the field experiments evaluated using factorial combinations of four preceding crops (faba bean, field pea, rapeseed and barley) with four nitrogen fertilizer rates (0, 18, 36 and 54 kg N ha<sup>-1</sup>) on Nitisols. As a result, the highest grain yield kernel plumpness, protein content and sieve test were obtained for malting barley grown after faba bean followed by rapeseed and field pea. On the other hand, in Australia, soil is high P fixation and low levels of plant available soil P only 10-20% of the applied P is utilized by crops in the year of application and subsequent usage of the residual P rarely exceeds 50% [30]. The potential benefit of P availability is the incorporation of P-mobilizing species into the cropping system [31]. Several legume crops like chickpea can mobilize soil and fertilizer P through the exudation of organic acid anions such as citrate and maltase and other compounds from their roots [32]. This method enables some of these species to acquire P from soil sources that are not readily available to non-secreting crops that are grown in intercrop or rotation with them. According to Meek et al., [33] crop rotation that follows alfalfa with maize or a crop with a similar nitrogen uptake pattern instead of bean will save nitrogen fertilizer lower soil NO<sub>3</sub> levels and reduce NO<sub>3</sub> leaching potential. Less deep leached NO<sub>3</sub>-N associated with the wheat lentil rotation due to better synchrony of nitrogen uptake from the lentil residue decomposition compared with wee fertilized continuous wheat [34].

Non legume crops may differ extensively by amounts of mineral due to nitrogen left in the profile. The residual remaining after a range of winter oilseeds is a major factor by determining subsequent wheat yields in the absence of disease [35]. Linseed had a shallower rooting system produced less biomass and left 30-50 kg/ha more nitrogen in the profile at harvest than canola or mustard. Accumulation of mineral nitrogen from break crop residues may also differ during the fallow period prior to cropping and this may not be simply related to C: N ratio of the residues. The benefit of nitrogen in nutrition in wheat may also arise from break crops since the healthier rooting system is enable to utilize the existing soil nitrogen or applied nitrogen more efficiently [36]. It is well known that crops use only some fraction of the applied organic and inorganic fertilizers. The remaining amount remains in the soil and uses for succeeding crops in the cropping sequence. Direct effects of applied S on mineral and residual effects on wheat were evaluated in maize-wheat cropping system. The application of S up to 40 kg/ha increased the average grain yield of maize by 9.9 Q/ha and the residual value of 40 kg S/ha increased the wheat grain yield by 5.4 Q/ha [37].

Cassava removes less of nitrogen and phosphorus per ton of dry product than most crops and similar amount of potassium. The role of cassava on improving soil fertility is attributed to high litter falls of cassava particularly during the dry season as well as incorporation of green leafy biomass of cassava after harvest. When harvested crop residues of cassava are ploughed back to the soil succeeding maize (*Zea mays*) benefits substantially from nitrogen released from

decomposition of cassava residues [38]. The accumulation of nitrogen fertilizer increases cereal protein yields in a continuous cereal rotation but the protein yield could not be elevated to the same levels as those obtained in pulse-cereal rotations [39]. In a long term cereal lentil rotation observed that microbial activity in the rhizosphere and rhizoplane of wheat grown after lentil increased highly compared with those in monoculture wheat [16].

**Effect on soil biological properties:** Soil biology in agriculture has historically dealt with the effect of agricultural practices on free-living organisms in the soil. Agronomic practice and variety of the seasons have affected the populations or activities of particular classes of soil organisms' per se in the bulk soil. The sequence of crops in rotation cannot only influence the removal of nutrients but also the return of crop residues, development and distribution of bio-pores and the dynamics of microbial communities [40]. Study in Ghana revealed that, six crop sequences using pigeon pea, cassava, cowpea-maize, groundnut-maize and maize-maize was evaluated to determine their effects on soil chemical properties and the productivity of subsequent maize. As a result, maize grain yield was highly influenced by crop sequence and grain yield ranged from 2.0 t ha<sup>-1</sup> with the continuous maize to 7.0 t ha<sup>-1</sup> on plot previously cropped to pigeon pea [24]. According to Upendra et al., [41] long term reduced tillage with continuous non-legume cropping increased dry land crop biomass, residue, soil carbon storage and soil quality by increasing microbial biomass and their activities than conventional agriculture like spring tilled spring wheat-fallow.

The advantages of cowpea were tested in terms of net nitrogen input by cowpea mono or intercropped with maize in a crop sequence where sparingly soluble P sources were added to the first year crop. The grain yield of maize grown after cowpea mono crop was doubled and the N uptake increased by 60% compared to maize following maize. The nitrogen value of growing cowpea mono cropped prior to maize mono crop was equivalent to the application of 50 kg N ha<sup>-1</sup> as mineral fertilizer. When maize followed a maize-cowpea intercrop grain yield was increased by 67%. Around 34% of the N contained in cowpea residues was recovered in the following maize [42]. The experiment was carried out at agronomy farm of Shere Kashmir on silty clay loam soil. The maize lentil cropping sequence recorded significantly higher grain yields of maize whereas maize-oats cropping sequence gave significantly highest yield of oats. Maize-oats cropping sequences supplied with 10 t FYM ha<sup>-1</sup> recorded significantly higher maize equivalent yield compared to other cropping sequences and rates and frequencies of FYM it also realized higher net returns and benefit cost ratio [43].

Soil microbial organisms can be influenced by several soil physical biological and chemical factors with the type of plant species grown, agronomic practices and chemicals used to control different pests. Within the soil microbial community bacteria are critical to nutrient cycling and are the dominant organisms within soils in terms of relative abundance with most soils containing >10<sup>9</sup> bacterial cells per

gram of soil, while some bacteria can cause plant disease most are beneficial [44].

**Effect on soil moisture conservation:** Dry land cropping systems can take advantage of stored soil moisture by alternating shallow and deep-rooted crops. For instance, alternate winter wheat a shallow-rooted crop with safflower a deep-rooted crop. Water use efficiency of maize improved 18 to 56% by including broadleaf crop in a grass based rotation [45]. Cropping systems in the northern Great Plains tend to be more diverse and research results suggest that seed yield of flax (*Linum usitatissimum* L.) can be tripled with a safflower (*Carthamus tinctorius* L.) flax crop sequence Vs a flax-flax crop sequence [10].

In a cropping sequence experiment of pea (*Pisum sativum* L.) in Northern Great Plains with fallow, mustard (*Sinapis alba* L.) and wheat (*Triticum aestivum* L.) to measure the effects of pea harvest timing and shoot biomass presence on soil water use and nitrogen contribution and yield and grain quality of subsequent wheat. Compared with maturity, midseason harvest timing of pea increased soil N (30-39 kg NO<sub>3</sub>-N ha<sup>-1</sup>) and soil water (19-39 mm) available in the spring to the subsequent wheat test crop at two of three sites. Under severe drought midseason harvest of pea increased wheat yield by 50% and critically increased grain density compared with the mature pea harvest. At the nitrogen limited site midseason harvest of pea increased wheat yield 14% and grain protein 9% compared with mature pea harvest. Pea shoot biomass presence did not affect soil water or nitrogen or growth of a subsequent wheat crop. Pea conferred stronger rotational benefits to wheat than mustard by conserving greater soil water and contributing greater soil nutrient particularly when growth was terminated midseason [46].

The availability of water is the biggest constraints to spring wheat production in the northern great plain of the USA. The most common rotation of spring wheat is with summer fallow is used to accumulate additional soil moisture [47]. Tillage during fallow periods control weeds which otherwise would use substantial amount of water decreasing the efficiency of fallow [45]. Chemical fallow and zero tillage systems improve soil water conservation allowing for increased cropping intensity [48]. Field trial was conducted in Northern Great Plains of the USA to compare productivity and water use of crops in nine rotations under two tillage systems, growing season precipitation was below average resulting in substantial drought stress to crops following fallow. Pre-plant soil moisture water use and spring wheat yields were generally greater than for chick pea or yellow mustard the only other crops in the trial that follows summer fallow. Following summer fallow and despite drought conditions zero tillage produced greater amount of soil water at planting than conventional tillage [47]. According to Mark et al., [49] report, the long fallow system has the potential to increase deep drainage by approximately 2 mm/year compared with a fully cropped system over a wide annual rainfall range (134-438 mm). There is evidence that water remaining in the profile after various crops is a more important determinant of soil water availability than differences due to water entering the soil from snowmelt [50]. One of the options to reduce the fallow period and increase water-use efficiency, crop yields and net returns is continuous cropping such as cereal-annual forage sequences [51]. In addition, annual forages in rotation with cereals maintains both cereal and forage yields because forages are harvested earlier for hay than cereals which results in greater soil water content and succeeding crop yields [52,53]. Intensification of crop production by reduction of summer fallow frequency provided more efficient utilization of the scarce water resource in the semiarid central Great Plains [51]. Increasing amounts

of residue returned to the soil increases the proportion of water stable aggregates and non-erodible dry aggregates [45].

**Effect on the control of soil erosion:** Soil erosion is one of the world's most serious environmental problems causing extensive loss of cultivated and potentially productive soil and crop yields [54]. Surface residue of crops is one of the most effective erosion reduction measures available. High residue producing crops following low residue producing crops help maintain higher levels of crop residue on the soil surface. Residue management practices such as mulch tillage or no-till can help maximize the amount of crop residue on the soil surface during critical erosion periods. Krupinsky et al., [55] stated that, crop residue coverage different and more clearly associated with the second year crop than with the first year crop of a two year crop sequence and cropping sequences composed of spring wheat, millet and grain sorghum has high crop residue coverage. Soil coverage by crop residue as affected by ten crop species under no-till in the northern Great Plains was reported a range of 35 to 98% crop residue coverage of soil depending on how two crops were sequenced. Residue coverage was high with crop sequences that included small cereal grains spring wheat and barley (*Hordeum vulgare* L.) intermediate with small cereal grain and a dicotyledonous species combination and low with only dicotyledonous species [47].

Various crops have different growth and development periods hence one crop may provide protection from erosive forces during a period of the year that another may not. The differences in crop residue coverage of soil among crops can be related to the amount of residue produced by a particular crop residue position (standing vs. flat), decomposition, and management practices. The rate of residue decomposition varies; for example, wheat residue decomposes more slowly than red clover (*Trifolium pratense* L.), canola, or dry pea residue [56]. Legume rotations are an important practice for maintaining soil fertility for farmers primarily as grain legumes provide both food and high quality crop residues [57] and soils with low organic matter contents are more erodible [54]. Cropping systems that consist of continuous row crops and excessive tillage have a higher potential for wind and water erosion than rotations includes closely spaced row crops or perennial crops. Closely spaced row crops such as small grains or perennial crops provide more canopy and surface cover than wide row crops and reduce the potential for erosion. Crop residue retention on the soil surface substantially reduces runoff, erosion and can decrease soil evaporation and land preparation costs. Residue retention can improve soil structure and water holding capacity and residue retention will improve long term nutrient cycling [58]. Bulk density and the saturated hydraulic conductivity of soil increased slightly with erosion rate [59]. Most of the time, the greatest erosion hazard in cropping systems occurs if tillage and/or summer fallowing are practiced after a lower residue. Merrill et al., [60] measured the wind erosion of a silt loam soil on no-till-managed sunflower stubble land (sunflower following spring wheat), which was subjected to various degrees of spring tillage treatments (no-till, medium-till, and heavy tillage conventional) followed by chemical (glyphosate) summer fallowing. The combination of tillage and chemical weed control under relative summer dryness resulted in unacceptably high levels of wind erosion. Even the no-till treatment had moderately elevated measured levels of soil loss under a high energy windstorm event [60]. Under the low input production systems of the smallholder farmers, rotation of maize with cassava and grain legumes could be considered as an alternative cropping system that returns large quantities of crop residues to the soil and sustains maize yield [61].



According to Merrill et al., [50] surface residue coverage measured at the time of spring wheat seeding indicated that crop sequences composed of spring wheat; millet and sorghum had the highest surface residue coverage whereas sequences composed of two alternative species such as chickpea, lentil, dry pea, sunflower and corn had lower surface residue coverage. For the period of drought, inadequate crop growth and consequent low residue e presence will negatively synergize with soil erodibility factors to increase wind erosion risks [60].

### Effect of cropping sequence on disease, insect and weed control

**Effect on disease control:** Crop sequence/rotation in combination with other management practices can be one of the most effective and inexpensive methods to manage a number of plant diseases [62]. Cropping sequence is an important management practice that may lower the risk for leaf spot diseases of spring wheat. Field research was conducted ear Mandan, in the USA to determine the impact of crop sequences on leaf spot diseases of spring wheat following 10 crops. The result indicated that leaf spot diseases on spring wheat were impacted by crop sequencing. Spring wheat following crop sequences with alternative crops for 1 or 2 yr had lower levels of disease severity compared with a continuous spring wheat treatment [63]. The bacterial populations in soil may contribute to crop health and by controlling the growth of plant pathogens. Cropping sequences had considerable effect on soil microbial community structure. Bahia grass rotation with peanut was found to have the highest bacterial diversity. Sudini et al., [64] reported that, higher bacterial diversity was observed with bahia grass and corn rotations compared with continuous peanut. Crop sequences and crop rotations take advantage of the fact that plant pathogens important on one crop may not cause disease problems on another crop. Proper crop sequences lengthen the time between susceptible crops in order that pathogen populations have time to decline. While pathogens may not be completely eliminated by crop sequence rotating among crops type reduces the amount of inoculum pressure on the crop being grown [55]. Crop rotation allows time for the decomposition of residue on which pathogens carryover and natural competitive organisms reduce the pathogens on the remaining residue although unrelated crops are being grown [65]. Furthermore, pulse crops are reducing cereal disease incidence [17,66].

**Effect on insect pest and nematode control:** A number of production techniques and practices like crop rotation, tillage, adjustments in planting and harvesting dates, trap crops, sanitation procedures, irrigation scheduling, fertilization, physical barriers are used to control pests in crop lands. Tillage practice and crop sequence, the population density of the reniform nematode and *Rotylenchulus reniformis* with different soil depth [67]. The population densities of *R. reniformis* on corn and grain sorghum were low throughout the soil profile. In plots planted with spring cotton and fall corn every year fewer nematodes were found at depths of 60-120 cm in the conservation agriculture and ridge tillage systems than in the conventional tillage. Population densities were lower at depths of 0-60 cm than 60-120 cm. Soil moisture and cotton root length did not affect nematode population densities in the field. Population densities resurged to the same high levels as in soil planted with cotton every year during one season of cotton [67]. The soybean cyst nematode is one of the most serious threats to soybean production in most soybean growing countries and regions in the world [68]. Senyu [69] reported that, soybean (*Glycine max* L.) Merr. Cyst nematode (SCN),

*Heterodera glycines*, and soybean yields in corn soybean crop sequence indicated that growing SCN-resistant cultivars was effective in the corn-soybean rotation for managing SCN and minimizing yield loss to SCN.

**Effect on weed control:** Various crop rotations are one of basic methods of improved weed managing systems. Weed tend to associate with crops that have similar life cycles. For example, the common association of spring cereals is wild oat (*Avena fatua*). Crops with different life cycles disrupt population growth of weed species, consequently lowering weed density in following crops [70].

Bread wheat yields reduction due to the use of unproductive crop management practices is common in wheat production in Ethiopia. thus in order to obtain the best methods of production crop management trials were conducted in the south-eastern highlands of Ethiopia to examine the effects of alternative practices for crop residue management, tillage and cropping sequence on wheat grain yield and the severity of infestation by the grass weed *Bromus pectinatus*. Along with the crop residue management treatments stubble burning tended to increase the grain yield of wheat and decrease the severity of *Bromus* infestation in contrast to partial removal and complete retention of stubble. Faba bean (*Vicia faba*) included in a faba bean-wheat-wheat cropping sequence markedly increased wheat yields and reduced *Bromus* severity. Cropping sequence markedly affected the grain yield of wheat with the faba bean rotation consistently outperforming continuous wheat. *B. pectinatus* infestations in wheat were reduced by rotation with faba bean and stubble burning [71]. Rape seed has compounds that are enzymatically hydrolyzed upon tissue disruption to release a variety of biologically active compounds including isothiocyanates which are toxic to certain insects, fungi, nematodes and weeds [72,73]. As a result, it seems that the production of allelochemicals to soil after rape seed planting decreases the weed growth and pest population and improves wheat yield [74].

### Conclusion

Intensive land uses with continuous growing of similar crops significantly affect soil health and crop growth. Currently, most smallholders cultivate crops with different cropping sequences to optimize crop system. The selection of sequence based on agricultural system, finance and environmental condition. Conventional monoculture agricultural systems can reduce the quality of soils by loss of organic matter and soil structures. The accumulation of crop residues with frequent inclusion of pulse crops in a rotation is given away to improve the biochemical and physical properties of the soil via increasing the labile of organic matter. Surface residue of crops is one of the most effective erosion reduction measures and different crops have different growth and development periods thus, one crop may provide protection from erosive forces during a period of the year that another may not. In addition to this, crop rotation in combination with other management practices like tillage, adjustments in planting and harvesting dates, trap crops, sanitation procedures, irrigation scheduling and fertilization can be a physical barriers and most effective and inexpensive methods to manage a number of plant diseases and pests. In general, crop rotation is practicing the entire world since it can solve an important management practices particularly for developing countries where monoculture becomes hazardous for the environmental conditions.

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