International Journal of Environmental Trends (IJENT) (1), (1), 2017, 54-63

The Applications of No-tillage in Turkey

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ABSTRACT

No-tillage is economically viable, erosion limiting crop production system in which the crop planted directly into the previous crop's stubble with minimum soil disturbance.When compared to conventional tillage, the no-tillage system provides nitrogen accumulation in the soil and also improves soil aggregation and moisture holding capacity. In addition, the no-tillage increases N and C concentrations, microbial carbon mass, and bacterial and fungal populations. It also reduces CO_2 and NO_2 emissions and fuel consumption, and increases crop yield over long periods. There are several factors that are effective in the success of this system. These factors include the type of no-till seeder, stubble condition, sowing depth and time, crop rotation and the selection of the varieties. When studies on this subject are examined, it can be said that there is a need for more specific researches in order to spread the no-tillage rapidly throughout the country. For the foreseeable future, facilitating national development strategies for up-scaling of no tillage, conducting training course with national organizations remain a high priority to promote no tillage systems. Our purpose in this research is to examine the scientific publications and projects about no-tillage in Turkey and to discuss the difficulties in the implementation phase of the method. It is also one of the goals of trying to discuss the advantages and disadvantages of Turkey for no-tillage and conventional tillage.

Keywords: Benefits, Conventional tillage, No-tillage, Turkey.

1. INTRODUCTION

No-tillage, 'direct drilling" 'or 'direct seeding' are all terms describing the sowing of seeds into soil that has not been previously tilled in any way to form a 'seedbed'. Direct drilling' was the first term used, mainly in England, where the modern concept of the technique originated in the 1960s. The most commonly identified feature of no-tillage is that as much as possible of the surface residue from the previous crop is left intact on the surface of the ground, whether this be the flattened or standing stubble of an arable crop that has been harvested or a sprayed dense sward of grass.

No-tillage has many advantages and disadvantages.The advantages of no-tillage are fuel, time and labor conservation, increased the soil organic matter and soil nitrogen, preservation of soil structure and earthworms, improved aeration and infiltration, reduced irrigation requirements, germination of weeds and pollution of water ways, lower cost and increased crop yields. Disadvantages of no-tillage are risk of crop failure, larger tractors required, new pest and disease problems, and no-tillage seeder selection and weed control in the first years.

In order to be able to see the expected effect from the no-tillage, it is necessary to evaluate a number of factors together during the crop production period.The most important factor for the success of this system is no-till seeder type which used the no tillage. The first step in implementing no-tillage is to place the seeds precisely at the desired depth. It is used specially designed machines to achieve this purpose. No-till seeders have a more specific design than other sowing machines due to their untilled or stubble-covered fields. The most spectacular units of these machines are furrow openers that can plant in untilled soil conditions.

In addition to furrow openers, row cleaners, press wheel and covering chains are among other vital parts of these machines. Row cleaning units remove stubble on the row and a clean row space is obtained. The pressure wheel ensure that the seed- soil contact. Finally, the seeds are covered with soil using covering units and sowing is completed. The sowing depth at the time of sowing should be homogeneous for obtain a good seed emergence. The density and distribution of stubble on the surface of the field is another factor affecting the sowing success. If the moisture content of the stubble is inevitable, furrow opener cannot cut the stubble. Furthermore, if the stubble is not homogeneously distributed on the surface of the field, the seeder cannot sowing to the desired depth. However, furrow opener of no-till seeder should not bury stubble into the soil, because prevent seed-soil contact.

Soil fertilizer at the time of sowing is important for seed germination and crop yield. Without soil tillage to stir and mix applied fertilizer applications, careful attention must be paid to placing the fertilizer in untilled soils to optimize crop uptake and yield. Bands of fertilizer to the side and below the seed have proved to be very effective, sometimes utilizing one fertilizer band for each pair of seed rows. While it is important to place fertilizers far enough away from seeds and seedlings to avoid toxicity problems, it also appears that separation distances can be much closer than those commonly accepted for tilled soils. Fertilizer banding has been found to be optimally accomplished by simultaneously seeding and fertilizing with a combination direct seed drill and fertilizer dispenser, and which is now common practice.

Energy is required for all agricultural operations. Practices that require lower energy inputs, such as no-tillage versus conventional tillage, generally result in lower inputs of fuel and a consequent decreases of CO_2- carbon emissions into the atmosphere per unit of land area under cultivation. Emissions of CO_2 from agriculture are generated from four primary sources: manufacture and use of machinery for cultivation, production and application of fertilizers and pesticides, the soil organic carbon that is oxidized following soil disturbance (which is largely dependent on tillage practices) and energy required for irrigation and grain drying.

The aim of this research is to examine the problems of the no-tillage method applied in Turkey. For this purpose, we examined that machinery manufacturing companies, stubble management, scientific researches and projects, and Turkey’s advantages and dis advantages for no-tillage.

2. MATERIAL AND METHODS

The materials of this study are statistical results, scientific studies and projects and interviews with farmers. As a method, it is considered that the findings obtained from these studies are discussed according to a specific subject line.

Climate properties of Turkey

Turkey is located in the middle Europe, Asia and Africa. Turkey surrounded at north Black Sea, at south Mediterranean Sea and at west Aegean. While the coastal areas have moderate climates, the Anatolian plateau has extremes temperature both in summer and winter. Turkey receives most of the rainfall in the winter season. In this season, mean temperature usually is below 5°C and there is no too much evaporation. Summer season is very limited in terms of rainfall and it is necessary to irrigation in this season. The Aegean and Mediterranean coasts have rainy winters and hot summers, also annual precipitation in these areas varies from 580 to 1300 mm according to the locations. Black Sea coast has great potential of rainfall. The eastern part of this area receives 2200 mm annually. Marmara region is milder climates (winter 4°C and summer 27°C); in winter however the temperatures can drop below zero. In Western Anatolia, there is a mild Mediterranean climate with average temperatures of 9°C in winter and 29°C in summer. On the southern coast of Anatolia has a similar climatic condition. The temperature difference between night and day is very high. It can be seen snow in this region instead of rainfall. The average temperature is 23°C in summer and -2°C in winter. Black Sea area is wet, and humid (summer 23°C, winter 7°C). In the Eastern Anatolia region has a long winter, and snow remains on the ground from November until the end of April (the average temperature in winter is -13 °C and in summer 17 °C). In the South-Eastern Anatolia region, summers are hot and dry, with temperatures above 30°C. Spring and autumn are generally mild, but during both seasons sudden hot and cold spells frequently occur in the region.

Arable area distribution of Turkey

According to Turkish Statistical Institute's data there are 23762572 ha agriculture land in Turkey. In this agricultural area sown area, follow area, vegetable production, fruit production and Ornamental plant production are done with 15574371 ha, 4049998 ha, 804142 ha, 4844 ha, respectively. Arable area distribution in Turkey was given in Figure 1.

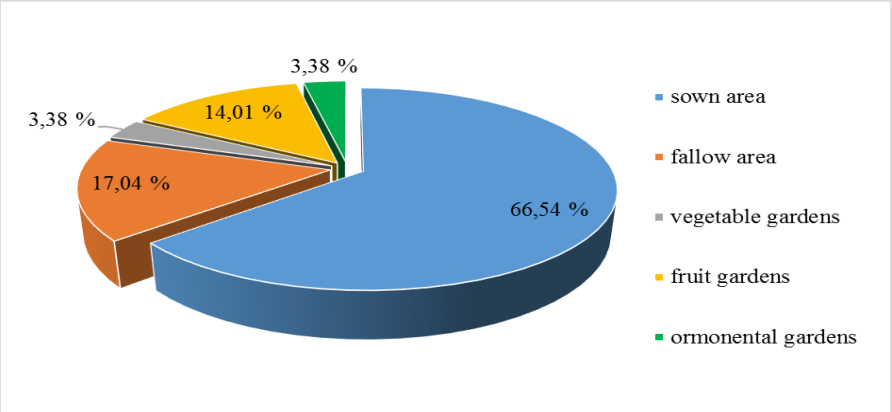

Figure 1. Arable land of Turkey

Turkey has a great agricultural potential. The main farming systems are dry and irrigated farming. According to the results of Crop Production Survey (Turkish Statistical Institute) the most planted crops in 2016 were wheat and sunflower 7687 and 8407 ha respectively. These plants were followed by barley, clover, cotton and maize production (2743, 1900, 1248 and 1105 ha).

No-tillage projects and scientific researches in Turkey

Numerous scientific researches and projects have been carried out in different geographical

regions, climatic conditions and rotation systems in Turkey. There are completed and ongoing projects in the country in relation to the subject. As a main factor in these projects, the subjects such as conservation tillage and no-tillage, crop rotations agronomy and weed control have been examined. In the projects, the products were grown in irrigated and not-irrigated soil conditions and got an idea about the efficiency of the conservational tillage and no-tillage. Some projects related to no-tillage and conservation tillage in Turkey are given in Table 1.

As in the case of the projects, the method of conservational tillage and the no-tillage has been the subject of scientific publications. In the scientific researches, soil physical properties, seed emergence and crop yield parameters were investigated. In the majority of these scientific publications, soil bulk density, porosity, penetration resistance, moisture exchange of soil in seed germination period are evaluated within soil physical properties. In addition, weed control has also been the subject of research in the no-tillage. The problem of weeding must be overcome for the farmers in order to accept the no-tillage. In these publications, it is explained in detail how to make struggle with weed control. In addition, the most effective crop rotation and water management that can be used in areas where research has been conducted is also emphasized in these scientific studies. Numerous scientific studies have been carried out to develop the no-till seeders. In these studies, the designs of furrow-opener are the foreground. In particular, the angles of furrow openers, furrow opener types have been researched and various suggestions have been made. Some scientific publications related to the subject in Turkey are given in Table 2. Despite the fact that there are many projects and scientific publications about the subject in the whole country, there are still a lot of topics to be investigated. One of the most crucial of these issues is the farmers' adoption and implementation steps. The acceptance of this method in Turkey depends on the practices of the farmers themselves in their fields. For this reason, scientific studies should be carried out in farmers' fields together with farmers. With such an approach, the farmer will be able to learn how to follow the adaptation process.

Soil tillage machinery distribution in Turkey

The majority of the arable land in Turkey is tilled by conventional tillage practices. This unsustainable soil tillage method negatively affects the physical, chemical and biological quality of the soils. In the conventional tillage system soil is tilled by plough, cultivator, disc harrow and land roller. As a result of this intensive tillage, the soil is much more disturbed and thus increases the fuel consumption and soil compaction. Turkey also has farmers who follow and implement innovations in the subject of agriculture. These farmers imitate other farmers by applying new methods. In this respect, progress has been made especially in the field of tillage. In some parts of the country, farmers that has large agricultural lands tend to conservation tillage and no-tillage. Across the country the number of farm machinery that using conventional tillage is 1909524 according to TUİK's data (2016). The number of no-till seeder in Turkey is less than other conventional sowing machines. However, the number of no-tillage machines has increased over the years. Approximately 40 companies manufacture farm machines throughout the country, but the companies that manufactured no-till seeder is only 7. In the last 15 years there was a government support which covered 50% of the no-till seeder cost and 361 pneumatic no-till seeder was sold. The number of no-till seeders were given in figure 2.

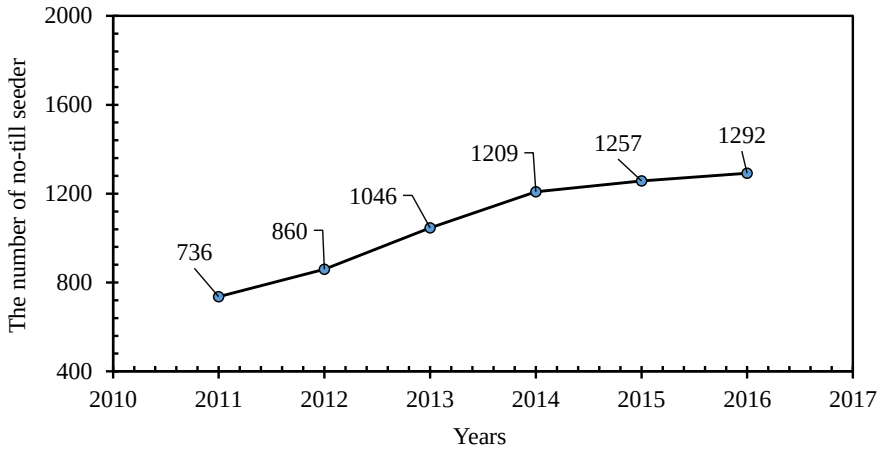

Figure 2. The number of no-till seeders in Turkey

The problems of no-tillage in Turkey

In Turkey, some problems are encountered in the application of conservation and no-tillage. No-tillage may cause reductions in crop yield in the first years. However, when analyzed economically it appears that this decline in crop yield is not serious. The method must be applied for at least 4 years in order to be able to see the expected effect of the no-tillage. During this time, the amount of soil organic matter, microbial population and soil physical properties will improve as a result, an increase in the yield of the product will be observed. Unfortunately, Turkish farmers do not expect the healing process of the soil and think that the method does not work economically.

The weed problem encountered during the application phase of no-tillage is another effect that makes production difficult. In the solution of the problem, herbicides are used effectively. Total herbicide application, especially before sowing, allows sowing to be done smoothly. The weed problem encountered in plant growth period can be solved by chemical and mechanical methods.

Plant rotation is an important parameter in terms of protecting soil fertility and weed control. However, crop rotation that is effective in one region may not give the same results in another region. For this reason, the type of crop rotation appropriate for each region should be decided. Another problem encountered during the production period is rodent damage. This problem can be solved using predators.

In no-tillage system, the soil surface must be covered with stubble. In this way soil is protected against water and wind erosion. The stubble on the soil surface protects the moisture content of the soil and accelerates plant emergencies. In Turkey, however, stubble is used as an animal nutrient. In order to solve this problem, there is a need for scientific studies on stubble management.

Table 1. Some of the past and ongoing conservation agriculture projects in Turkey

Subject	Location	Years	Systems	Crops	Researchers
Conservation tillage	East Anatolia	2003-2005	Rainfed and irrigation	Maize and sunflower	Prof. Dr. Ahmet ÇELİK Doç. Dr. Sefa ALTIKAT
No tillage	East Anatolia	2008-2011	Rainfed and Irrigation	Vetch and wheat	Prof. Dr. Ahmet ÇELİK Doç. Dr. Sefa ALTIKAT
Conventional tillage and soil compaction	East Anatolia	2003-2005	Rainfed and Irrigation	Wheat	Prof. Dr. Ahmet ÇELİK Doç. Dr. Sefa ALTIKAT
Conventional tillage and compaction	East Anatolia	2013-2014	Rainfed and Irrigation	Corn	Prof. Dr. Ahmet ÇELİK Doç. Dr. Sefa ALTIKAT
Machinery and	Central Anatolia	2007-2009	Rainfed	Wheat, chickpea	Prof.Dr.Kazm Çarman
Soils and Agronomy	East Mediterranean	2006-2009	Rainfed and irrigation	Wheat,corn,soybean	Prof.Dr. İsmail ÇELİK
Machinery and	Aegean	2001-2002	Irrigation	Cotton as a second crop	Prof.Dr. Erdem Aykas
Tillage and soil	Black sea region	2007-2009	Rainfed	Corn	Prof.Dr. Engin Özgöz
Subject	**Location**		**System**	**Crops**	**Researchers**
Machinery 3E	Central Anatolia		Rainfed	Wheat-Fallow	Prof.Dr. Kazım Çarman
Soil	Central Anatolia		Rainfed	Wheat-legume	Derya Sürek
Agronomy and soil	Southeastern Anatolia		Rainfed	Wheat-fallow	Ahmet Çıkman
Weeds Agronomy	South Eastern Anatolia		Rainfed	Lentil	Murat Urgun
Agronomy, and machinery	Eastern Anatolia		Rainfed	Wheat, vetch and fallow	Zinnur Gözübüyük

Table 2. Some of the academic publication of no-tillage and conservation tillage

Subject	**Location**	**Years**	**Crops**	**Researchers**
Performance of no-till seeders	Mediterranean	2006	Maize	Karayel, D, 2009 [1]
Tillage and energy consumption	Mediterranean	2006-2007	Maize	Barut *et al.*, 2012. [2]
Residue management and crop yield	East Anatolia	2003-2006	Cotton	Gürsoy *et al.*, 2010 [3]
Soil physical properties and crop yield	Southeastern Anatolia	2003-2004	Maize	Sessiz *et al.*, 2010 [4]
Tillage systems and economic analyses	Aegean	2004-2005	Wheat	Yalçın *et al.*, 2005 [5]
Tillage- energy analyses	Mediterranean	1999-2000	Corn	Öztürk *et al.*, 2008 [6]
Tillage- biomass-nitrogen content	Mediterranean	2007-2008	Soybean	Doğan *et al.*, 2011 [7]
Tillage-microbial properties	Mediterranean	2006-2009	Wheat	Çelik *et al.*, 2011 [8]
Tillage-energy analyses-crop yield	Southeastern	2003-2004	Sunflower	Sessiz *et al.*, 2008 [9]
Tillage-predators	Aegean	2000-2001	Cotton	Gençsoylu and Yalçın 2004 [10]
Tillage hydraulic properties	East Anatolia	2000-2012	Wheat-vetch	Gözübüyük *et al.*, 2014 [11]
Tillage –compaction-seed emergence	Eastern Anatolia	2006-2007	Red lentil	Altikat S, and Çelik A., 2011 [12]
Tillage-physical properties-crop yield	Eastern Anatolia	2004-2005	Maize	Çelik A and Altıkat S., 2010 [13]
Tillage-CO2 emission, microbial population	Eastern Anatolia	2005-2006	Common vetch	Altıkat *et al.*,, 2006 [14]
Tillage-stubble-sowing performance-crop yield	Eastern Anatolia	2004-2005	Maize and	Altikat S., 2012 [15]
Tillage-soil physical properties seed emergence	Eastern Anatolia	2008-2009	Summer vetch-	Altikat and Çelik 2012 [16]
Tillage-soil physical properties-seed emergence	Eastern Anatolia	2008-2009	Vetch-wheat	Altikat S., Çelik A 2012 [17]
Tillage and equipment	Eastern Anatolia	2008-2009	Wheat	Çelik and Altikat 2012 [18]
Tillage – Stubble distribution	Eastern Anatolia	2008-2009	Vetch-wheat	Altıkat S, Çelik A., 2012 [19]

3. RESULTS AND DISCUSSION

A large part of the land of Turkey (67%) has erosion risk and thus intensive soil tillage and open channel irrigation systems very dangerous for Turkey's arable land. In the conservation tillage especially no-tillage the soil less distribution and plant water consumption is less compare to conventional tillage. For these reasons the spread of the conservation tillage and no –tillage throughout the country is very important for Turkey's farming.

The number of firms producing direct sowing machines in Turkey is less than that of conventional sowing machines. In some researches, it is stated that the no-till seeder produced in Turkey cannot sow at the desired level. The biggest reason for this is the fact that farmers do not have enough knowledge about the use of these special no-till seeders. These machines must be calibrated to soil conditions before they can be used. Farmers use the machine without any calibration. Thus, the desired effect is not observed. The farmers should buy the type of machine suitable for his soil conditions. Particularly, it should be ensured that the machine's furrow openers, press wheels and closure systems work smoothly at the time of sowing.

Turkish farmers have to use this method personally for their adoption. To this end, demonstration work should be accelerated throughout the country. Livestock is an important source of livelihood in Turkey. In Turkey, stubble is used as a nutrient source in the livestock sector. This is an important problem in terms of the application of conservation agriculture. From this perspective, effective stubble management is inevitable for protective tillage applications.

Another significant trouble for no-tillage in Turkey is weed control and rodent damage. In the short time scale these trouble can be solved with used herbicides and insecticides. At the long time scale crop rotation can be solved these trouble. Effectiveness of the no-tillage can be changed with regionally.

Turkey has some outstanding features compare to others neighbor country about application of no-tillage system. There are sophisticated farm machinery industry across the country. Besides, Turkey has well established agricultural research, developed and extension institutes, widespread agricultural chambers network, widespread farmer machinery ownership, high quality seed registration system and trade, no sanctions or limitations for trade and government support.

4. CONCLUSION

Intensification of agricultural practices in Turkey caused a lot of problems in Turkey's land. At the beginning of these problems are the deterioration of soil properties and inefficiency of arable land. At the last 10 years a lot of land converted to the arable land. And thus, the number of tilled land rapidly increased. At the result of this this unsustainable increase of agriculture land has been caused risks by monoculture practices, and excessive irrigation and tillage. The most of the Turkey's agriculture land has erosion risk due to dominant steep slopes (>6%).More than 55% of arable lands in Turkey are severely affected by water erosion. Further to this, 5% of arable lands are subject to wind erosion.

When these factors are considered conservation tillage practices, especially no-tillage must be used by Turkey's farmer. In no-tillage system soils protected from water and wind erosion compare to conventional soil tillage systems because soil's surface cover with stubble and use

less water during the growing period.

Farming decision making process is very important for spread no-tillage throughout the country. No-tillage is relatively complex system and involves a wide range of intervening factors. Hence farmers are supported during this complex process. The importance of local farmer discussion groups is critical to successful adoption of new technologies and innovations.

Affordable, dependable and adoptable no-till machinery development is one of the greatest challenge for the agricultural machinery producers. Machinery producers should be given adequate support to fine-tune their no-till drills. Researchers and no-till machinery producers should work in collaborate to address possible site-specific issues.

ACKNOWLEDGE

This study was presented in the "3rd International Conference on Science, Ecology and Technology" in 2017.

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