NO-TILLAGE AROUND THE WORLD

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Abstract. No-tillage farming is a way of cultivating crops every year without disturbing the soil through tillage. It has great benefits, not only on short term, reducing the amount of mechanical work and fossil fuels needed, but also on long term, increasing the water quantity that infiltrates into the soil, the fertility, the organic matter retention and reducing the soil erosion. The idea of Edward Faulkner in the 1940s was developed after the WWII, around the world, in 2009 being used on 111 million hectares. No-tillage is now being practiced from the sea level up to 3000 m, from extremely rainy to very dry areas. The countries from South America have the fastest adoption rates, in some of them no-tillage being used on more than 70% of the cultivated area (Brazil, Argentina, Bolivia, Paraguay, and Uruguay). It is also used in the U.S.A and Canada, Europe (Germany, Spain, and Finland), Asia (China, Kazakhstan, and India), Australia and Africa (Morocco, Tunisia). All crops can be produced adequately using this system. The wide range of conditions where it can be applied and its economic, social and environmental advantages should ensure the expansion of this technology in the next years.

Key words: (no-tillage, conservation agriculture, long and short term advantages)

No-tillage is a system based on cultivating the soil without previous plowing. In this way, the crop residues are left on the topsoil, creating a permanent layer which protects against hydric and wind erosion (Hobbs P.R., 2007). At the same time, the organic matter can be better oxidized, the soil aggregates are more stable and the water infiltrates more easily. Nowadays, in almost every country there are at least some activities in no-tillage (FAO, 2014). Area under no-tillage has expanded to climates and soils earlier thought inadequate for practicing this technology successfully. It is now being practiced by farmers from the Arctic Circle, over the tropics to about 50º latitude south. From sea level in several countries of the world up to 3000 m altitude, from extremely dry conditions with 250 mm precipitation a year, to extremely rainy areas with 2000 or 3000 mm a year. It is practiced on all kinds of farm sizes and soils that vary from 90% sand to 80% clay (Derpsch R. et al., 2010). All crops can be produced in this system.

In 1999, the area under conservation tillage was 45 million ha. Ten years later, it was 111 million ha and the latest values presented by FAO show that this technology has spread rapidly, on almost 155 million ha (*table 1*) (FAO, 2014).

The expansion of the area under no-tillage was higher in the South America, being used on more than 70% of the cultivated area in countries like Argentina, Brazil, Paraguay and Uruguay (FAO AQUASTAT, 2014). More than 2/3 of this surface is permanently under this system, meaning that once started, the soil is never tilled again. USA and Australia also adopted the technology on wide areas. The slowest adoption rate is found in Europe, Asia and Africa.

North America

USA. In 1943, Edward H. Faulkner wrote "Plowman's Folly", a book in which he suggested that farmers should leave crop residues on the soil, rather than plowing. Even if the book was a great success, the idea of not using the plow before sowing a crop was met with high skepticism among scientists (Triplett G.B. and Dick W.A., 2008). After the World War II, emerged a new form of farming, using herbicides rather than plowing to control weeds. Those chemicals, along with the machinery designed to plant seeds through crop residues, set the start for no-tillage farming. In 1997, the technology was used on more than 19 million ha, representing about 50% of world's total at that time (Derpsch R. et al., 2010). In 2004, the area under no-till was 25.3 million ha. Nowadays, it's applied on 35.613 million ha, representing around 25% of the cultivated land in the USA (Montgomery D.R., 2008).

Canada. In Canada, no-till had a similar development as in the USA, due to erosion problems. The regions with high percentage of adoption are Saskatchewan (60.1 %), Alberta (47.8 %), Ontario (31.2 %), Manitoba (21.3 %) and

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British Columbia (19 %) (Derpsch R. and Friedrich T., 2009). Being used in the year 2000 on only 8.8 million ha, no-tillage has spread on 18.313 million ha in 2013 (FAO, 2014).

Table 1

Area under no-tillage worldwide (FAO AQUASTAT, 2014)

Country	Area under Conservation Agriculture (ha)
Argentina	27 000 000
Australia	17 695 000
Azerbaijan	1300
Belgium	268
Bolivia	706 000
Brazil	31 811 000
Canada	18 313 000
Chile	180 000
China	6 670 000
Colombia	127 000
Democratic Republic of Korea	23 000
Finland	200 000
France	200 000
Germany	200 000
Ghana	30 000
Greece	24 000
Hungary	5 000
India	1 500 000
Iraq	15 000
Ireland	200
Italy	380 000
Kazakhstan	2 000 000
Kenya	33 100
Kyrgyzstan	700
Lebanon	1 200
Lesotho	2 000
Madagascar	6 000
Malawi	65 000
Mexico	41 000
Morocco	4 000
Mozambique	152 000
Namibia	340
Netherlands	500
New Zealand	162 000
Paraguay	3 000 000
Portugal	32 000
Republic of Moldova	40 000
Russian Federation	4 500 000
Slovakia	35 000
South Africa	368 000
Spain	792 000
Switzerland	17 000
Syria	30 000
Tanzania	25 000
Tunisia	8 000
Turkey	45 000
Ukraine	700 000
United Kingdom	150 000
United States of America	35 613 000
Uruguay	1 072 000
Uzbekistan	2 450
Venezuela	300 000
Zambia	200 000
Zimbabwe	332 000
Total	**154 810 058**

Latin America

Argentina. In the early 1970's, several farmers started experimenting with no-till system, but they gave up, because of the lack of adequate machinery and herbicides. In 1986, there was founded the Argentinian Association of No-till Farmers (AAPRESID – Asociacion Argentina de Productores En Siembra Directa), which helped the development and spread of the technology, by organizing conferences every year, with more than 1000 farmers (http://www.aapresid.org.ar). Since then, this country had an exponential grow of no-till farming, abandoning the idea that tillage was necessary to grow crops. The latest values show that "siembra directa" is applied nowadays on 27 million ha, making Argentina one of the most successful countries in term of no-till adoption.

Bolivia. The first area under no-tillage in Bolivia was settled in 1986, by Dr. Jean Landivar on his farm of 2000 ha, for maize, sorghum and some soybeans (Derpsch R. et al, 2010). Since then, the area under this technology has increased constantly, from 240000 ha in the year 2000 to 706000 ha in 2007 (*table 1*).

Brazil. The first experiment on no-tillage was started in 1971, by Rolf Derpsch and a year later, Herbert Bart, the first farmer who tried this technology in Latin America, introduced this system on his farm. Even if it took 20 years for Brazil to reach the first million ha under this technology, in 2012 there were reported 31.811 million ha (www.febrapdp.org.br). About 70 % of no-tillage is practiced permanently, meaning that most farmers never till the soil again. The Brazilian farmers also use the green manure cover crops, on millions of ha, considering that they are an important part of the no-till system (Derpsch R. et al., 2005). The wide spread of the technology was possible because there were quickly produced the machinery and equipment needed.

Chile. Carlos Crovetto was the first farmer who used no-till in Chile, in 1978, understanding the long term benefits of this system on soil physical and chemical properties. Nowadays, in this country, no-till is used on 180000 ha, in other words, on about 30% of the cropped area in rainfed farming systems (FAO, 2014).

Colombia. In Colombia, due to the insecurity in rural areas and the political situation, the area under no-tillage hasn't increased much in the last decade. If in 2005, there were 102000 ha under this system, in 2011 there were reported 127000 ha (FAO AQUASTAT, 2014).

Mexico. In this country, the area on which no-till is applied has increased from 22800 ha in 2007, to 41000 in 2011 (FAO AQUASTAT, 2014).

Uruguay. Uruguay had a great adoption rate of the no-tillage system along the years, with 337500 ha in 1999, 655100 ha in 2008 and 1.072 million ha in 2013. The integration of crop production with livestock is very popular in this country. Pastures are used for several years, and then the land is used for crops according to the needs of the farmer (www.ausid.com.uy).

Venezuela. In 2005, there were reported 300000 ha under no-tillage for this country (Derpsch R., 2005).

Europe and Russian Federation

Finland. Finland is one of the countries in Europe which had adopted no-till in a very fast way. In 2011 there were reported 160000 ha. Two years later, the area had expanded to 200 000 ha. The rapid adoption of the technology was due to the fact that people believed in the success of the technology and spread their experience to others. Also, there were manufacturers that produced quickly the planters needed for no-tillage, helping a lot the farmers.

France. In France, in 2005, there were reported 150000 under no-tillage. From 2008, the area has remained constant, of about 200000 ha (FAO AQUASTAT, 2014). In this country, experiments with conservative agricultural systems were started in 1970, by INRA (Institut National de la Recherche Agronomique) and ITCF (Institut Tehnique des Cereales et des Fourrages) (Boisgontier D. et al, 1994), in order to reduce labor time, production costs and to increase productivity (Goulet F., 2004).

Germany. Even if the first experiments with no-tillage started in Germany in 1966 (Baumer K., 1979) and the results show that this technology has a lot of advantages on short and long time, the adoption rate is still very low. In 2013, there were reported 200000 ha under this system (FAO AQUASTAT, 2014).

Italy. In Italy, the expansion of the technology started in the 1990s, in order to reduce the costs (De Vita P. et al, 2007). The area under no-till was of 80000 ha in 2005 and in 2013, this country was cultivating using this technology on 380000 ha (*table 1*).

Spain. The researches regarding the no-till system started in the 1980s and nowadays, Spain is the leading country in terms of adopting this technology. It is applied on 792000 ha, according to the latest values provided by FAO, with annual crops represented by wheat, barley and much less maize and sunflower (FAO, 2014). The first world congress on conservation agriculture took place in Madrid in 2001 (Garcia-Torres L. et al., 2001) and also, the third Mediterranean meeting on no-tillage took place in 2006, in Zaragoza (Arrue J.L. and Cantero-Martinez C., 2006). The reasons of adopting no-till in Spain were mainly, the machinery and input costs, need for tillage simplification and time requirements for other agricultural activities (Lahmar R., 2008).

Romania. The experiments with no-tillage started in in 1960s, at the Research Institute from Fundulea (Şarpe N. and Poenaru S., 2004), and after that, in other research centers also, but because of the lack of specialized equipment and weed problems, the results weren't very convincing. Nowadays, in Romania are used variants of the reduced tillage system, but there is no official data regarding the total area under conservation tillage.

Switzerland. One of the countries in which no-tillage practices tend to spread is Switzerland, because of the reduction of the soil erosion. According to Swiss No-till, in 2010 was applied on 12500 ha, representing 3.5% of the cultivable area of the country, and the latest values show that the technology has spread, on 17000 ha (www.no-till.ch).

Ukraine. The area under no-tillage, as shown by FAO, has increased quickly, from 600000 ha in 2011, to 700000 ha two years later, Ukraine being the second European country after Spain in terms of using this technology (FAO AQUASTAT, 2014).

Russian Federation. In 2011, there were reported 4.5 million ha under conservation agriculture for this country, demonstrating that the farmers are interested in the advantages provided by its use (FAO, 2014).

Africa

The no-till technology in Africa is in its early stages of adoption.

Northern Africa. In this part of the continent, no-till has been promoted particularly in Tunisia and Morocco (Derpsch R. et al., 2010). It is used on 8000 ha in Tunisia and on half of this area in Morocco (FAO AQUASTAT, 2014).

South Africa is using no-till on 368000 ha, despite the limited rainfall and erosion problems in many regions this country is experimenting.

Southern and Eastern Africa. Due to its advantages, no-tillage has been adopted by many countries in this part of the continent: Kenya (33100 ha), Malawi (65000 ha), Mozambique (152000 ha), Tanzania (25100 ha), Zambia (200000 ha), Zimbabwe (332000 ha) (FAO AQUASTAT, 2014).

Asia

China has started no-tillage experiments in 1960s, but the work was not extended and failed. In 1992, thanks to an ACIAR project, the researches were taken up again and succeeded.

Nowadays, China is using conservation agriculture on 6670000 ha (FAO, 2014) and also produces many types of no-till seeders for smaller tractors (Gao H.V. et al, 2007). In the Beijing region, more than 85% of the farm land is under conservation agriculture (Derpsch R. et al., 2010). The main reasons for adopting of no-tillage in China were represented by the low level of soil organic matter and high wind and water erosion (Li H.W. et al., 2007).

India. The Indian farmers adopted no-till in the rice-wheat double cropping production system and has been adopted primarily for the wheat crop (Derpsch R. et al., 2010), because, due to the time needed to do the tillage, the sowing was delayed and so, the yields were reduced. The official data provided by FAO (2014) show that last year, India had 1.5 million ha under this system.

Kazakhstan. In this country, no-till was introduced between 2002 and 2004 in Conservation Agriculture project, by FAO and CIMMYT. It had extremely good adoption rates, with 600000 ha in 2007, 1.8 million ha in 2008 and 2 million ha in 2013 (FAO AQUASTAT, 2014).

Australia has great adoption rates of the no-till technology, due to its advantages. The area has increased from year to year, from 9 million ha in 2005, to 17.695 million ha in 2014 and it's expected to spread even more, in the next years (FAO, 2014). Another common practices among Australian farmers are the use of cover crops, the controlled traffic farming to avoid soil compaction and the combination of cropping and livestock (mainly sheep) (Friedrich T. et al., 2009).

New Zealand is one of the first countries in adopting the no-till system. At the beginning, the farmers tried pasture renovation without tillage and succeeded and later on, they continued with annual crops. Nowadays, the system covers around 25% of the total cropland, including pastures and forage crops, representing 162000 ha (FAO, 2014).

Conclusions

Due to its benefits, not only on short but also on long time, the no-till system is expected to spread in the next years on more land, not only in the countries where is already used, but also in others. A better understanding of the concept is needed, along with the support of each government and institutions from the field, so farmers to be aware of the advantages:

- Reduced soil erosion;
- Less machinery;
- Lower costs;
- Reduced irrigation;
- Improved moisture conditions;
- Increased yields due to higher water infiltration and storage capacity;
- No tillage pan means roots can grow deeper;
- Increased farm efficiency;
- Improved soil structure;
- Increased water use efficiency;

There are some barriers to be overcome for a better adoption rate of the system: knowledge on how to do it (know how), mindset (tradition, prejudice), inadequate policies as commodity based subsidies (EU, US), availability of adequate seeding machines and suitable herbicides.

ACKNOWLEDGEMENTS

This paper is published under the frame of European Social Fund, Human Resources Development Operational Programme 2007-2013 project no. POSDRU/159/1.5/S/ 132765.

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