

MINIMUM TILLAGE AND ORGANIC AGRICULTURE AS ALTERNATIVES FOR SUSTAINABLE AGRICULTURE

VENERA MIHAELA STROE

National Research and Development Institute for Soil Science, Agrochemistry and
Environmental Protection of Bucharest

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Abstract

"A sustainable agriculture is an ecological agriculture economically viable, socially responsible, protect resources and serve as the basis for future generations" P. Allen.

Continued use of the classic tillage of the soil has led to a gradual increase in production, but causes adverse events disturbing on the most important resources of agricultural production, soil, by physical and chemical degradation.

This paper is a synthesis of research on agricultural technology systems belonging to the conservative side (with a correct pedological foundation and by avoiding mistakes in plant growing agricultural technology, which reduces soil degradation), research carried out both in our country and abroad that supports this type of farming like an alternative for preserving the natural fertility of the soil and a method of environmental protection, with beneficial effects on human health and the positive economic impacts.

INTRODUCTION

Soil degradation is a highly complex process that causes or enhances the action of one or more limiting factors. In conventional agriculture, the intensification of land degradation is determined mostly by human activities, and less than some limiting factors, which generally have a permanent character, cannot be removed, so that agricultural technology must be adapted. This category included soil texture, too high or too low content of clay or sand. Also other limiting factors affecting natural fertility and soil productivity are: primary compaction, acidity, salinity, excess and water scarcity, low content of organic matter and nutrients, nutritional imbalances; some of them can be remedied by measures more or less simple ameliorative agriculture.

MATERIAL AND METHODS

Tillage systems: *Conventional*-ploughed at different cm; *Unconventional*-disk harrow, chisel + rotary harrow, paraplow.

Physical properties as: soil bulk density, by the core method (Black and Hartage, 1986); water stable aggregates by the procedure of Kemper and Rosenau (1986);

aggregate size distributions were determined on the soil samples collected from the fields before sowing of different cultures, during the vegetation season and immediately after harvesting.

The Anova procedure was used to evaluate the significance of each tillage treatment on macrostructural hidrostability degree. Treatment means were separated by the least significance differences test and all significant differences were reported at the 5%, 1% and 0.1%.

RESULTS AND DISCUSSION

At present, there is an increase of the technologies with reduced soil tillage. In the U.S., from 1972 to 1981 with work surfaces and sown directly into stubble varieties increased from 12 to 39 million ha, representing about 9, respectively, 30% of the total sown area [3]. Intensifying and worsening the effects of degradation as a result of technical mistakes has led the international scientific community to launch a comprehensive program that has identified the main processes of soil degradation (dismantling, erosion, compaction secondary, agrochemical degradation, acidification, biological disturbances) cases and affected areas globally. Technological systems were tested varieties belonging to conservative agriculture for the first time in the U.S. and have seen a spectacular development in U.S., Canada, Brazil, Argentina where occupies between 12 and 40% of arable land.

FAO is promoting a change in the concepts and understanding regarding soil tillage and a reduction in the intensity and use of tillage equipment. It favors a greater use of conservation tillage techniques and related equipment and sustainable soil management practices. FAO has helped to disseminate information on the benefits of conservation tillage through education, technology transfer and input programmes as American Network of Conservation Tillage (RELACO) dedicated to the dissemination of conservation tillage systems.

The main objective of RELACO which started its activities in 1986, was to improve the utilization of soil, water and plant nutrients by generating and transferring tillage practices which prevent soil degradation. RELACO now has a membership of 16 countries (Argentina, Bolivia, Brazil, Costa Rica, Nicaragua, Paraguay, Peru, Dominican Republic, Venezuela, Chile, Columbia, Cuba, Ecuador, El Salvador, Honduras and Mexico).

The entrance of Chile into the global economy has led to important changes in the production of annual crops. Since 1991, there has been a negative tendency in agricultural productivity due to the use of inappropriate tillage systems intensify the natural soil degradation processes. As a consequence of the observed degradation problems, new tillage practices have been introduced into the coastal

mountain range, which allows inverting without seeding, harrowing or disturbing the soil, so that seeds are sown through the residues of the preceding crop.

Costa Rica showed also a high degree of soil erosion by tillage practices. Land use is intensive with a minimum of two crops per year, and hardly any crop rotation is practiced. The project MAG/FAO has piloted representative farms where was reduced number of disking, and especially of passes with the rotary cultivator type.

During the last 50 years, Mexico has suffered an accelerated deterioration. The potential contribution of conservation tillage has shown that it considerably diminishes soil erosion. In addition, there is a reduction in the number of weed species, the effect being most pronounced in systems with more than 60% residual cover. Thus, the area sown with conservation tillage in Mexico is 45.000 hectares, which represents only about 2% of the potentially cultivable lands, whilst the problem of soil degradation due to erosion continues year to increase at accelerated rates.

A part of Paraguay is a fragile ecosystem. The agriculture of this region has been for about 60 years developing. The main crops are peanuts, cotton, sesame and euphorbia, with few winter crops. Soils show a reduction in productivity due to mono cropping, inadequate tillage and wind erosion.

Also for many years, in Venezuela, conventional tillage was a common practice. This has created serious problems of surface and subsurface compaction, erosion, surface crusting and sealing. Pilot plots have been established in farmers fields to enter direct sowing and minimum tillage on basic grain-producing in various regions.

Research projects designed to evaluate the effect of existing cover in conservation tillage systems on temperature, humidity, infiltration and other soil physical characteristics were carried out.

Studies in England showed that conventional tillage (1980-1995), organic carbon content was reduced by 50%, causing aggregates structural hidrostability damage, which affects water retention properties, the buffering, the availability of nutrients and biological activity and show the necessity of conservation soil tillage.

In a recent project by the UK Department of Environment Food and Rural Affairs [9] about the effects of minimal tillage, contour cultivation and in-field vegetative barriers on soil erosion and phosphorus loss is evaluated the potential for minimum tillage, also examine cost-effectiveness. Water erosion of agricultural soils has for many years, been recognized as a global environmental problem. In areas of the UK where soils are light in texture and readily erodible this problem can be serious, with rates of erosion typically between 0.5 and 200 mg ha⁻¹yr⁻¹.

Half of the field was cultivated with minimum tillage (shallow tillage with a tine cultivator) and half was conventionally laughed. Within each cultivation treatment there were different treatment areas. In the first year of the experiment, one TA was

cultivated up and down the slope, one TA was cultivated on the contour, with a beetle bank acting as a vegetative barrier partway up the slope, and one had a mixed direction cultivation treatment, with cultivation and drilling conducted up and down the slope and all subsequent operations conducted on the contour. In the second year, this mixed treatment was replaced with contour cultivation.

The results showed no significant reduction in runoff, sediment losses or total phosphorus losses from minimum tillage when compared to the conventional plough treatment, but there were increased losses of total dissolved phosphorus with minimum tillage.

Research undertaken over the soil and conditions in the last 40-50 years, in central Europe showed the wheat crop suitability conservative tillage systems [3, 4].

In Romania, the system works for the maintenance of soil has not expanded greatly because of the impossibility of fitting a range of specialized machines that perform a single pass a large number of operations and technology mainly due Drills Cutter equipped mainly with the patina requires good preparation germinative bed [4]. Tillage with paraplowul or carved tamping can replace tillage land, with arable horizon short and reduced infestation with perennial weeds species, to grow deep-rooting plants-corn, sunflower. Gus and collaborators showed, in 1991, that the maintenance of soil work clearly helped to conserve soil and increase its fertility.

After Hays (1972) and Carter (1994) - quoted by Petcu (1998), the system works requires the maintenance of soil: basic work to be done without turning the swath, in which loosening runs with carved or disc harrow, harrow or rotary cultivators, arrows, etc.; number of ground works to be reduced to the classical system.

The experiment carried out during 2000 - 2005 in the experimental field of Research Centre - Sustainable Agricultural Minimum Systems Technology and discipline of the UASVM Agrotechnics Cluj had good results with paraplaw system work.

In a recent project in Romania [16], the technology variety sowing in the Banat plain on a preluvosol with moderate suitability to direct sowing, the results favorable for soybean crop and winter wheat, and a trend-sensitive growth and presence compaction enlighten secondary soil profile and accumulation of phosphorus in the upper soil profile. Recommended long-term crop rotation and making entries on the ground only under optimum conditions of soil moisture trafficability. The result was improvement of soil fertility and productivity of fine textured.

Also, this technology tested on chernozem cambic fine textured, moderately compacted, at the Burnas plain required a good management of the plant remains cropping. The land must be free of any weeds, diseases or pests. Seeding can be performed only under optimum conditions of soil workability to allow a good

contact between soil-seed. Complex equipment include: displaced mill, drill, roller track in aggregate with CASE – 7340.

The results obtained in the Burnas plain showed that fewer crossings surface for carrying various items of raising and processing of soil before planting can help reduce time increasing physical soil degradation of compaction by avoiding secondary emphasis, increasing soil permeability water, avoid excess water from the surface, improving the potentials of aeration, storage conditions and the available water for workability [16].

It is interesting to note that on other continents carry out complex research regarding environmental effects of organic and conventional agriculture interdisciplinary. So, long periods of time farms in North Island (New Zealand) have developed the organic technology (biodynamic). Organic farms have improved physical and chemical soil properties.

In Finland 3,900 organic farms were registered in 2008 (5.6% of all farms) and 150.000 ha (6.5% of the country's agricultural area). Finland is the largest producer of organic oats in Europe (second in the world after Canada).

Research in organic farming has a long tradition in Germany, Biodynamics Research Institute founded in 1950, is one of the first private institute in the world.

At the end of 2007 were recorded about 18,703 certified organic farms which cultivate 865.000 hectares (Figure 1). Compared with 2006, the number of organic farms increased by 6.5% and surfaces organically grown by 4.8%. Overall, 5% of germane farmers have grown 5.1% of Germany's total land area under organic standards. The total number of companies, including agro-ecological producers, manufacturers, and trade companies has increased by 11.9% (total 26,820 companies in 2007). In 2007, retail trade of organic products increased to 1.18 billion euros [10, 11, 12].

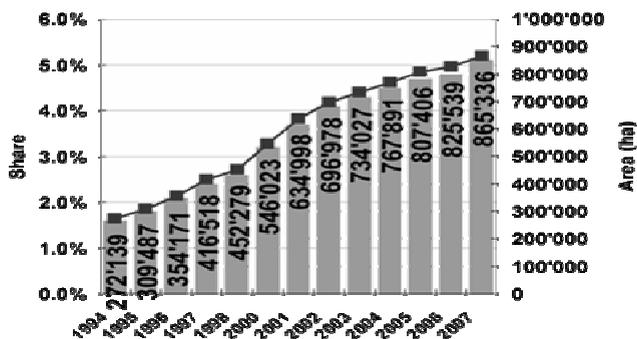


Fig. 1. Evolution of land farmed organically in Germany, 1994 - 2007. Source: soil, AGöL, BLE, ZMP, August, 2008

In Romania, systematic research on organic vs. differentiated technologies conventionally have been started recently with the implementation of European Union schemes, which subsequently pursued a practical implementation of results through development of agro-environmental programs. Research was carried out under the Phare project "Demonstration Centres for Sustainable Agriculture in the Danube Basin and the Regional Study on Market Aspects".

Organic fertilization was performed with composted manure from the cattle farm. The effects of organic and conventional agricultural technologies on soil and groundwater (Figure 2) were studied in a network of piezometric installed ICPA Bucharest. The study links mobile fauna in differentiated technologies impact culture was carried out by installing a network of traps Barber and taxonomic determinations from ICPA Bucharest, while soil samples for evaluation were collected edaphic mezofauna samples and analyzed by a team of researchers at the ICB Iași [17]. Under organic practices, about 175 earthworms were found per square meter compared to 21 frames per square meter in the conventional variants These large differences are due obviously fundamentally different way of dealing with chemical pesticides. During 2003-2005, the impact of conventional technologies on organic soil was monitories in farms from Călărași County (2005). So, the plots were developed under organic certification and inspection program. Maintaining an acceptable level of soil organic matter was done almost as in typically Mediterranean organic farms based on plant debris and green manure, as a consequence of reduced livestock sector. Only organic vegetable plots were fertilized in 2005 with 5 t/ha compost sheep/cattle. Plant protection treatments were carried out with cupric substances allowed in organic production.

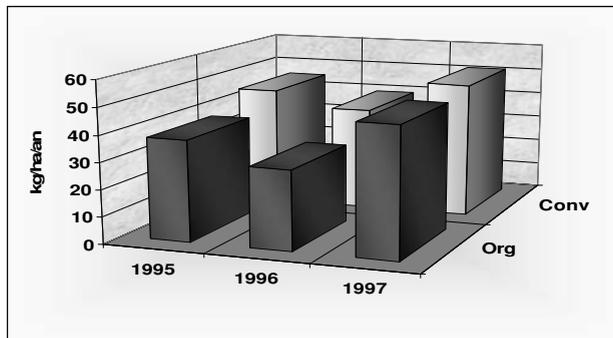


Fig. 2. Flow of nitrogen to groundwater under conventional and organic farming technologies (green) on a clay soil, Cincșor, Brașov. Source: Ștefănescu and al., 2000

The experiment showed that it was desirable to maintain the pragmatic agriculture, rather than conducting assessments of the academic type [17].

Although investigations in Călărași were relatively short, there is a slight trend of improvement in the chemical, physical and biological soil properties in ecological agriculture. The conventional plots were recorded in soil nitrate in normal quantities but higher than the ecological (green). Also, in conventional plots were found traces of pesticide residues and very high levels of cadmium content. Analytical data on the structural stability indicate a slight superiority of water stability under organic practices.

According to these results, it is recommended for organic farms in southern Romania to carry out more careful crop rotation program with regular organic fertilization. Also, it would be useful to organize a field experimental approach to include complex impact of soil physical characteristics. The motivation of this approach is fundamental lack of relevant data at European level and the results of previous research showing that among the problems of soil degradation on agricultural land in East Central European area is secondary compaction (FAO, 1999).

CONCLUSIONS

1. The international agricultural policies adopted in the years 1960 - 1970 helped increase the area under cereals and root crops. Therefore, there was also increased tillage, high risk on the occurrence and worsening erosion, which spread rapidly, especially in Asia and Africa, also Europe, including in our country.
2. Fluid erosion and wind erosion have become, by far, the worst forms of land degradation, affecting about 1094 million ha, can be found in all continents.
3. Secondary compaction captive over the past six decades is the best known form of physical degradation in conventional farming systems, intensive mechanized.
4. The worldwide area affected by deterioration-compaction is about 83 million hectares, of which most 68 million ha, are common in Europe.
5. Mechanical technologies and preventive measures recommended should be developed locally to avoid the primary and secondary soil compaction.
6. Organic farming schemes connected with agroambiental have become notable in European policies.
7. FAO supported the creation of a network, called Latin American Network of Conservation Tillage dedicated to the dissemination of conservation tillage systems.
8. Argentina, Paraguay, Chile, Bolivia, Mexico, Venezuela, U. K. applied in different conditions of soil and climate a conservative agriculture with minimum tillage or no tillage;

9. In our country, research on soil systems maintenance work has been performed in recent years focusing on quantitative aspects (production) and their impact on soil quality and environment.
10. For the organic farms in southern Romania a crop rotation program with organic fertilization was carried out. Also, it would be useful to organize a field experimental approach to include complex impact of soil physical characteristics.
11. In Romania, most relevant research has been carried out under Phare project "Demonstration Centres for Sustainable Agriculture in the Danube Basin and the Regional Study on Market Aspects" with results in the agricultural area of the town Cincșor.
12. Finland is the largest producer of organic oats in Europe, and Germany research in organic farming has also a long tradition.

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