Summary

PhD thesis topic is "**THE INFLUENCE OF UNCONVENTIONAL TILLAGE SYSTEMS ON THE PRODUCTIVE PROPERTIES OF THE SOIL**". The doctoral dissertation is structured in ten chapters, 294 pages, 130 tables and 81charts and pictures and has two distinct parts: the first part is a synthesis of bibliographical data on the subject of doctoral thesis, on the natural climatic conditions during testing, material and research methods. In the second part we are presenting the results of research.

Intensive agriculture with heavy machinery can cause soil deformation by compaction and shearing which results in changes in soil properties. For e correct assessment of the impact of management practices on the soil environment, it is necessary to quantify the modifications of the soil properties.

When we have to choose a tillage system, we have to think at soil properties, plant and climatically conditions which can influence or can be influenced by that system *(Franzluelbers A.J., 2002).* In general, the relative success of reduced and no-tillage systems in Romania is strongly affected by weather and soil type. Many farmers are reluctant to switch from conventional systems to disk or chisel practices because of concerns about compaction, especially in the early years after conversion.

Soil compaction, due to repeated passes with tillage machineries on its surface, leads to major changes in physical, chemical and biological properties. The most notable changes are recorded for bulk density, compaction degree, porosity, penetration resistance and soil hydro-physics indices. Reduce pores volumes, especially the macropores, have the effect of drastically reducing the oxygen content of the soil, thus influencing plant roots breathe, solubility and absorption of nutrients, the activity of soil micro-organisms, water quality and its movement. Symptoms of nitrogen or phosphorus deficiency are very common in plants grown on

compacted soils, thus reducing significantly the yield and also the crop residues at the soil surface.

The scientific literature of our country demonstrates the existence of incomplete areas approached regarding unconventional tillage systems and the necessity to intensify research area for the promotion and development of new systems for soil conservation. Thus, the present work aims to bring new data on the influence of unconventional tillage on soil production characteristics.

The main objectives of the research are:

- ✓ Expanding cultivated areas in the conservative tillage system in the ecological area of Moldavian Plateau, based on research results,;
- ✓ Establishing what tillage system is capable to ensure optimum conditions for plant growth in a certain crop rotation; when we choosing a tillage system should be considered not only the immediate considerations, but also the long term, to ensure productivity and profitability and to conserve soil resources;
- ✓ Knowledge of favourable factors for crop growth of winter wheat, soybean, maize and ecological potential of cambic chernozem form Ezăreni Farm.
- ✓ Quantifying changes in 0-30 cm soil profile due agricultural machinery traffic;
- ✓ Highlighting the settlement of soil state due conventional and unconventional tillage using bulk density and penetration resistance parameters;
- ✓ Quantifying the effect of classical and conservative tillage systems on chemical properties of soil;
- ✓ Analysis of the influence of tillage systems on soil microorganisms;
- ✓ Highlighting the effect of crop rotations and mineral fertilizers on yield and productivity elements;
- ✓ Optimizing energy relations in production process.

The experiment was initiated in 2005 and carried out at Ezăreni – The Experimental Farm of the Agricultural University of Iaşi, in the East side of Romania ($47^{o}07`$ N latitude, $27^{o}30`$ E longitude), on a cambic chernozem (SRTS-2003, or haplic chernozems according WRB-SR, 1998), with a clay-loamy texture, 6.8 pH units, 2.7 % humus content and a medium level of fertilization. The experimental area has an annual average temperature of $9.4^{o}C$ and precipitation of 587 mm. The experimental design was in a "split plots design" with three replicates. Plots covered area of 60 m^2, in a rotation of soybean, winter wheat and maize.

To achieve the goals set for this study and to highlight the influence of conventional and unconventional tillage on soil properties were sampled soil in different growing stages,

paying particular attention to how and when to do sampling soil. Observations were made continuously throughout the period of vegetation, as there may be unexpected changes in plant development, mainly due to adverse climatic variations.

To determine bulk density, compaction degree and soil porosity core samples were taken from each variant of tillage, after the sowing, during vegetation period and at harvesting, with steel cylinders of 100 cm^3, from 0-10 cm, 10-20 cm and 20-30 cm soil profile, for all three crops.

To quantify the influence of tillage system on soil structure, disturbed soil samples were taken from 0-10 cm, 10-20 cm and 20-30 cm depth at sowing, on growing stage and harvesting, using the set of Eijkelkamp augers.

Soil penetration resistance (Pr) was measured after sowing, during the growing period, and at harvesting, using a digital penetrologger (Eijkelkamp equipment, The Nederlands). Ten penetration resistance measurements were taken from each plot from the soil surface to a soil depth of 50 cm. The penetrologger had a 30^o cone and a 1 cm base area. At the same time were taken measurements to determine soil moisture using a Trim FM-3.

Agrochemical soil samples were collected at the beginning of experiments, form all treatments, up to a depth of 40 cm and on soil profile to 170 cm depth. At the end of the experimental period the analyses were repeated to determine the influence of conventional and unconventional tillage system on distribution of macro and micro nutrients on soil profile.

Soil sampling for microbiological analysis was conducted in classical aseptic conditions. Soil samples were collected in 2007-2008 agronomical year, from two depths: 7-10 respectively 15-25 cm, after a prior removal of the superficial layer represented mainly by plant debris. The soil samples taken have been examined at microscope for the control of their purity and as well to evidence the bacterial cells morphology. Concomitantly it has been studied the distribution of the microorganisms in arable layer.

Also it has been determinate the yield and the elements of productivity. Energetic efficiency was calculated with the basic energetic indicators like energetically balance, energetically efficiency, energetically effect, etc. Statistical analysis of data was performed using ANOVA with LSD test and regression curves.

Research conducted during the three years regarding the influence of classical and minimum tillage on the physical properties of soil has revealed a number of issues. Taking a look at the evolution of *bulk density* values from "sowing" to "harvest" crops, is observed increases in all variants and all depths, with higher amplitude in conventional tillage variants. The chisel treatment and the preparation of seedbed with the rotary harrow in a single pass for

this variant has the lowest value of the *compaction degree.* No matter what tillage system it has been used, we see the gradual increase of this parameter from "sowing" to "harvest". *Penetration resistance,* as mean values on the layer 0-50 cm, was not bigger than 2 MPa for paraplow, chisel, and plough at 20 and 30 cm, for soil moisture content at the time of determinations. This value is defined as the upper limit for unrestricted root penetration by many researchers (*Taylor et al., 1966, Da silva A.P. and Kay B.D. 1997, Benjamin J.G. et al., 2003, Hamza M.A. and Anderson W.K., 2005, Veiga M. et al., 2007).* Exception is the disk harrow variant where was recorded mean values bigger than 2 Mpa.

Total porosity values ranged backwards bulk density, decreasing from "sowing" to "harvest". The analysis of data obtained after three years of investigations at winter wheat crop it shows higher values of *total porosity* in 2007-2008 compared with other years, indicating a better loosing of soil in this period, because optimal climate conditions that led to a good soil preparation and a very good plant development during the growing season.

The most common and accurate methods for assessing the structural condition of the soil refers to the determination of *water stability of soil aggregates*. Aggregate stability is a measure of the vulnerability of soil aggregates to external destructive forces (*Hillel D., 1982*). Also, represent the property of soil aggregates to resist at the dispersion action of water.

Soil hydric stability is increasing from “sowing” to “harvesting” and on soil profile, on all five tillage treatments, from the surface layer to 20 and 30 cm depth, as a result of negative influences of agricultural machines traffic on soil aggregates, raindrop impact on surface soil layer and other factors, this phenomenon attenuating with increase in soil depth.

Analyzing the values of *mean weight diameter* at five different experimental variants it has been observed that the specific technology of cereal crops produced a different evolution at winter wheat crop progress compared with corn and soybeans. Thus, there is a linear increase of *mean weight diameter* from "sowing" to "harvest" while emphasizing the differences between variants especially at the beginning of vegetation.

Comparison of original data with those obtained at the end of experiment shows very low oscillations of *pH* values during the three years, however there is a slight acidification of the surface soil layer at minimum tillage systems, the biggest difference, 0.12 pH units, being observed at chisel treatment.

As regarding the soil *total nitrogen* content, obtained after three years of experimentation, the values obtained are found in class considered as "high" (*Rusu M. et al. 2005*). Compared with 2005, when the soil form the experimental field was characterized as "medium" supplied with *total nitrogen,* in 2008 we observed an improvement. At the end of

2008, on the layer 0-20 cm, is found *mobile phosphorus* enrichment on four of the five experimental variants, except disc harrow variant, where a value less than 1 ppm to the original state has been found. As result of the rational agriculture system practiced, even if we didn't administered potassic fertilizers during the three years, analyzes shows an increases in *mobile potassium* in the soil surface layer. Analysis of 0-20 cm soil layer shows higher values of *humus* after three years of experimentation, especially in minimum tillage systems, as result of kipping at least 30% of organic material at the soil surface in unconventional tillage systems and the balanced relationship between mineralization and humification process.

Analyzing the correlation between "*bulk density x yield*" at winter wheat crop, it has been observed that yield decrease by about 19% for an increase of 0.1 g/cm^3 of bulk density, representing 953 kg/ha.

At all three crops - winter wheat, maize and soybean - while increasing the degree of mobilization of soil and fertilizer doses, increased both direct and indirect costs as active energy per unit area.

When we have to choice a proper tillage system should be considered not only the immediate argument but also long term, to ensure productivity and profitability but to be environmentally friendly and conserve soil and water resources.