ABSTRACT

The doctoral thesis **"OPTIMIZATION OF THE MACHINE SYSTEMS FOR THE IMPROVEMENT OF THE SUSTAINABLE AGRICULTURE CONCEPT IN THE NORTH-EAST OF ROMANIA"** was carried out during three years of field, laboratory and office research necessary for the interpretation of results and the writing of the thesis.

Deciding for any agricultural technological system must have as a scope the preservation and conservation of soil fertility, but it is unanimously accepted that the soil tillage carried out with conventional methods leads to the degradation of the soil, while the decline in soil quality deepens as a consequence of a faulted application of various technological components. Both the positive and the negative consequences have been the object of much research, nationally and internationally. As a result, nowadays there is a lot of information enabling the transition from conventional systems to modern technological systems of soil conservation (Stănilă, 2003).

Admitting the fact that environment degradation is closely related to the welfare of mankind and economic growth started in 1972 with the Environment Conference in Stockholm. Later, the World Commission on Environment and Development accredited to UN was established. This commission identified by 1987 over 60 definitions of the concept of sustainable development Rădulescu Carmen, 2003).

According to the Brundtland Report, sustainable development is defined as mankind's capacity to meet the present generation demands without compromising the capacity of future generations to meet their own needs (Report of World Commission on Environment and Development, 1987). Sustainable development includes criteria on ecosystem, soil, air and water protection, biodiversity conservation, all considering the needs of the future generations.

The transition to sustainable agriculture must take into consideration the request of maintaining a competitive agricultural sector which is economically efficient, while satisfying at the same time the fluctuating preferences of the consumers, ultimately leading to the development of agricultural products commerce, as well as environmental and resources conservation (*Jităreanu et al*., 2007).

Apart from direct sowing, the conservation technologies against weeds may also use mechanized tillage work combined with crop rotation and the application of herbicides.

As far as soil erosion is concerned, research has indicated, that apart from the no-tillage cropping system, no technology has been so far efficient in stopping this process or in the increase of agricultural yield. During the research carried out in 1991 by *Canarache A.* and *Dumitru E.* , they established that on 42% of the arable surface of Romania there are moderate and favorable conditions for unconventional soil tillage methods.

It can be mentioned that no future agricultural system will be able to totally exclude mechanized soil tillage, but a rethinking of tractors and agricultural machines construction is in question as well as a greater concern in the choice of tillage units (according to soil characteristics, climate and the plant's needs). Furthermore, it is necessary to make the adequate adjusting of the machines according to working conditions as well as reducing to the minimum the number of tillage work on the same surface.

Taking into consideration the above mentioned, this doctoral thesis has followed these objectives:

- The optimization of mechanized technologies of soil tillage, taking into consideration the sustainable development of agriculture;
- The impact of conservation technologies on the factors of wheat, maize and sunflower crop development;
- The reduction of gasoil necessary for the execution of the tillage;
- Determination of energy and quality work indices for agricultural units used in the studied technologies;
- The establishing of optimal indices for machine exploitation in the implementation of sustainable development technologies;
- Reduction of impact on soil from the machines′ working organs used for germinating seedbed preparation;
- Reduction of the number of field passing with agricultural units.

The experiments were carried out at the Experimental Station of the "Ion Ionescu de la Brad" USAMV Iaşi, Ezăreni Farm, during the agricultural years 2007-2009, on a cambic chernozem with a clayey loam texture and average to good fertility.

Research was carried out during three experiments (on wheat, sunflower, and maize) on a 200 m² plot surface for the autumn wheat and 400 m² for the plowing crops. The purpose was to identify the influence of different mechanized technologies on soil, yield, energy and quality indices for the following crops: autumn wheat, sunflower and maize.

For wheat were used five variants of soil tillage and sowing machines.

Furthermore, five different variants of the soil tillage and sowing were used for the two plowing crops.

During the crop tillage were determined the quality indices (average tillage depth, average tillage width, degree of soil grounding, land leveling degree, soil loosening degree, the degree of soil cover with vegetal residue, the degree of weed control, the degree of plant endangerment, protection area of plants) as well as the energy and exploitation indices (work speed, resistance to mechanical traction, the skidding of the tractor, fuel consumption by hour, usage coefficient of shift time, work capacity within an hour during the shift, work capacity during the 8 hour shift and the fuel consumption per hectare).

Samples have been taken at sowing in order to determine the current humidity of the soil, the structure units' distribution and the hydric stability of the soil structure. The fuel consumption per hectare was fixed and the seed production obtained.

The statistical interpretation of the research results was carried out with the method of variation analysis and included the following stages: establishing the degrees of freedom (DF), calculating the sum of deviation squares, making the variation table, calculating limit differences (LD) for transgression probabilities of 5%, 1% and 0.1%, calculating the differences to the sample test and establishing its significance.

The research on the optimization of mechanized systems for the implementing of the sustainable agriculture concept carried out at the Experimental Station Iaşi, Ezăreni Farm, on a cambic mezocalcaric regraded chernozem with a clayey loam texture highlighted a series of effects.

In the variant when the soil was tilled with a digger plough and a disc harrow, the soil layer of 0-8 cm presented itself as mellow, with a medium glomelural structure, but there are stuffed chumps, resistant to crumbling.

In the case of soil tilled with a vertical and horizontal cutter, the soil structure is glomelural, and the dominant structural elements are of small size, which will favor a deeper stuffing of the earth during vegetation.

The soil tillage with chisel or the paraplow plough had as an effect a satisfactory soil loosening.

Considering the droughty autumn, the direct sowing (with soil tillage on strips using the horizontal cutter and simultaneous sowing) had a beneficial effect on the emergence of wheat plants.

At the trials carried out it was observed that the resistance to soil penetration had, in general, appropriate values. There was no increase in the resistance to penetration due to the use of some machinery.

It has been concluded that the reliability of soil structure elements had, in general, appropriate values. The stability indices of the structure elements have indeed changed according to the number of machinery passing, the intensity of soil tillage done by these. However, the values of these indices fitted the limits of the agro-technical requirements.

At Variant V1, wheat crop, the soil grounding degree of the plough is good (71%), while the crumbling degree after passing three times with the disc harrow was low (75%).

Soil resistance to penetration had very low values (very good ones).

The weighted average diameter of the structure elements corresponds to the agro-technical requirements.

The hydric stability of the soil structure elements is very good.

In the case of variant V2 (wheat), the results are better than in variant V1, since the soil crumbling degree with the rotary harrow was very good (98,9%), the soil resistance to penetration has very low values (very good ones) while the weighted average diameter of the soil structure elements and the hydric stability of these elements correspond to the agro-technical requirements.

With variant V3 (wheat), the soil crumbling degree by the chisel is good (61,3%), and the crumbling degree by the rotary harrow is very good (98,9%).

Soil resistance to penetration had very low values (very good ones).

The weighted average diameter of the structure elements corresponds to the agro-technical requirements.

The hydric stability of the soil structure elements is very good.

For the wheat crop, variant V4, the soil crumbling degree by the complex aggregate AGPS-24DR+OA (loosening organs fixed in front of the complex aggregate) is good (92,6%).

Soil resistance to penetration had very low values (very good ones).

The weighted average diameter of the soil structure elements is very good (5, 01 mm).

The hydric stability of the soil structure elements is very good.

For variant V5 (wheat) the soil crumbling degree by a combined machine MCR-2,5 (horizontal cutter working on rows + universal seeder) was very good (100%).

Soil resistance to penetration had very low values (very good ones).

The weighted average diameter of the soil structure elements is very good (5, 63 mm).

The hydric stability of the soil structure elements is very good.

For the wheat crop, if the choice has been made for the conservation soil tillage systems, without the use of the digger plough, I believe that the variants to be applied, starting with the best, are the following: V5, V4 and V3. If the conservation systems of soil tillage cannot be applied or the tillage is recommended to be performed with the overturn of the mobilized soil

layer, using the digger plough, it is estimated that the best variant to be applied is V2.

For the sunflower crop, variant V1, the soil crumbling degree by plough is good (71 %), and so is the crumbling degree after one passing with the disc harrow (87 %).

Soil resistance to penetration had very low values (very good ones).

The weighted average diameter of the soil structure elements corresponds to the agro-technical requirements.

The hydric stability of the soil structure elements is very good.

In the case of variant V2, sunflower, the results are better than in variant V1, since the soil crumbling degree with the rotary harrow was very good (98,9%), the soil resistance to penetration has very low values (very good ones) while the weighted average diameter of the soil structure elements and the hydric stability of these elements correspond to the agro-technical requirements.

With variant V3, sunflower, the soil crumbling degree by the chisel is good (61,3 %), and the crumbling degree by the combiner BS-400A is very good (98, 8 %).

Soil resistance to penetration had very low values (very good ones).

The weighted average diameter of the structure elements corresponds to the agro-technical requirements.

The hydric stability of the soil structure elements is very good.

For the sunflower crop, variant V4, the soil crumbling degree by the paraplow plough is good (63,7 %) while the soil crumbling degree by the horizontal cutter FPP-1,3 is very good (98,2%).

Soil resistance to penetration had very low values (very good ones).

The weighted average diameter of the soil structure elements is very good (5, 21 mm).

The hydric stability of the soil structure elements is very good.

For variant V5, in sunflower, the soil crumbling degree by a complex unit (horizontal cutter FPL-4 + precision seeder SPC-4) was very good (100 %).

Soil resistance to penetration had very low values (very good ones).

The weighted average diameter of the soil structure elements is very good (5, 66 mm).

The hydric stability of the soil structure elements is very good.

For the sunflower crop, if the choice has been made for the conservation soil tillage systems, without the use of the digger plough, I believe that the variants to be applied, starting with the best, are the following: V3, V5 and V4. If the conservation systems of soil tillage cannot be applied or the tillage is recommended to be performed with the overturn of the mobilized soil layer, using the digger plough, it is estimated that the best variant to be applied is V2.

For the grain maize crop, variant V1, the soil crumbling degree by plough is good (71 %),

and so is the crumbling degree after one passing with the disc harrow (87 %).

Soil resistance to penetration had very low values (very good ones).

The weighted average diameter of the soil structure elements corresponds to the agro-technical requirements.

The hydric stability of the soil structure elements is very good.

In the case of variant V2, for maize, the results are better than in variant V1, since the soil crumbling degree with the rotary harrow was very good (98, 9%), the soil resistance to penetration has very low values (very good ones) while the weighted average diameter of the soil structure elements and the hydric stability of these elements correspond to the agro-technical requirements.

With variant V3- maize, the soil crumbling degree by the chisel is good (61,3%) and the crumbling degree by the combiner BS-400A is very good (98, 8%).

Soil resistance to penetration had very low values (very good ones).

The weighted average diameter of the structure elements corresponds to the agro-technical requirements.

The hydric stability of the soil structure elements is very good.

For the maize crop, variant V4, the soil crumbling degree by the paraplow plough is good (63,7 %) while the soil crumbling degree by the horizontal cutter FPP-1,3 is very good (98,2%).

Soil resistance to penetration had very low values (very good ones).

The weighted average diameter of the soil structure elements is very good (5, 28 mm).

The hydric stability of the soil structure elements is very good.

For variant V5, in maize, the soil crumbling degree by a combined machine MCR-2,5 (horizontal cutter working on rows + universal seeder) was very good (100%).

Soil resistance to penetration had very low values (very good ones).

The weighted average diameter of the soil structure elements is very good (5, 57 mm).

The hydric stability of the soil structure elements is very good.

For the maize crop, if the choice has been made for the conservation soil tillage systems, without the use of the digger plough, I believe that the variants to be applied, starting with the best, are the following: V5, V3 and V4. If the conservation systems of soil tillage cannot be applied or the tillage is recommended to be performed with the overturn of the mobilized soil layer, using the digger plough, it is estimated that the best variant to be applied is V2.

One must mention however, that after some years, the inappropriate use of the machines leads to a degradation of the soil, tamping it, fragmenting the structure elements, and producing a strong mineralization of the organic matter, the humus, etc. For these reasons one should use those mechanized technologies in soil preparation that ensure its highest possible conservation.

The alteration of the soil tillage concept seems to be an economic, agro-technical and organizational necessity. The future evolution in the field of soil tillage tends towards a decrease in tillage depth, the replacement of plowing with the tilling done by disc harrow or machines that do no overturn the furrow (chisel, paraplow) as well as the direct sowing on the untilled land.

By implementing the concept of sustainable agriculture and establishing some appropriate technologies we will have: conservation of the soil structure and even its improvement, reduction of hydric and wind erosion, production surpluses or a production equal to that realized in the conventional system, significant reduction of fuel consumption, work time, and of the number of land passing with the agricultural units.

For a fully aware application of the different soil processing systems it is necessary for one to know the advantages and disadvantages, the variation of certain economic and agrotechnical indicators, the imposed requirements for the unconventional soil tillage systems, performance indicators on productivity, costs, profit, etc. all of which are fixed during research. The obtained results contribute to a better understanding of the conservation technologies as opposed to those applied up to present times.