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# HABILITATION THESIS

## AGROTECHNICAL MEANS FOR INCREASING PRODUCTION AND IMPROVING SOIL FERTILITY

**Domain: Agronomy**

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## **ABSTRACT**

The habilitation thesis entitled “**Agrotechnical means for increasing production and improving soil fertility**” includes, briefly, the results of the researches conducted in various experimental sites from Moldova Plain.

The results obtained from the long-term experiments with different crop rotations, various soil tillage methods, crop fertilization systems and methods for the arrangement of hydrographic basins with slope lands, contributed at establishing the technologies for the cultivation of plants and improving soil fertility and reducing the erosion processes.

The results obtained from the studies on establishing crop rotation for soil protection against erosion were published in two ISI Thomson indexed journals and 22 papers indexed in international databases: CAB International, Copernicus International, Genamics Journal Seek Database, AGRIS and so on.

The studies on establishing the strategies for erosion control benefited of an interdisciplinary approach so to control these processes with agrotechnical means, agro-pedoameliorative and land improvement works.

The recommended agrotechnical works for increasing the agricultural production, improving soil fertility and protecting the quality of soil and water relied on studies and experiments of more than 35 years. The analysis equipment and methods were modern, recognized at national and international level.

The habilitation thesis includes the scientific and professional accomplishments, the career development plans and the bibliography. The scientific results are presented in five chapters, each of them including an agrotechnical measure or a method for arranging the eroded areas; it contributes at improving soil fertility and increasing the production level. The paper also includes some of the results from the studies, the agropedological mappings and risk factor assessment from Moldova Plateau, to establish the solutions for protecting the quality of the environmental factors and for promoting sustainable agricultural systems.

Chapter 1, entitled “Studies on the physical – chemical characteristics of the soils from experimental fields” presents the degradation of soils and the extent of the erosion processes from the hydrographic basins of Podul - Iloaiei, Scobîlțeni and Popești, where the experimental fields were situated. After mapping 2480 ha from the southern area of Moldova Plain, on the territory of Podu-Iloaiei, Dumești and Popești communes, the results indicated that the surface erosion phenomenon is the most frequent one, 43% of the total, followed by landslides 21.3% and deep erosion 0.36%. Digital maps were created for these hydrographic basins. They included land

slope, usage categories, slope orientation, soil types and some of their features that represent the first steps in gathering the information needed to follow the evolution of various processes as erosion, flooding, landslides, compaction, salinization degree etc. These studies were conducted respecting the COM Directive (2006) 232 for the protection and preservation of soil capacity to fulfil environmental, economic and social functions.

Chapter 2 includes the results of the studies on the influence of crop rotation on soil production, erosion and fertility. On the inclined lands the extended wheat-corn rotation with crops fertilized with large amounts of mineral fertilizers ( $N_{140}P_{80}$ ), determined, after 35 years, the decrease of organic carbon content in the soil, from 19.3 g/kg to 16.9 g/kg. The peas – wheat-corn-sunflower + one reserve field with leguminous plants and perennial grasses, determined the increase of organic carbon content in the soil by 14.7% (2.8 g / kg) compared to the wheat – corn rotation.

Chapter 3 presents the results of the studies referring to the influence of fertilization systems on yield and soil fertility. Using the dose of  $N_{80}P_{80}$  + 30 t/ha manure on the crops from the peas-wheat-corn rotation, generated, after 35 years of experiments, the increase of organic carbon content in the soil from 18.8 g/kg to 19.5 g/kg on the highly eroded soils and from 18.8 to 21.3 g/kg on the weakly eroded soils. This chapter also includes a presentation of the technologies for the use of the sewage sludge from Iasi Sewage Water Treatment Station and for the use of other organic resources coming from farms as it is the case of vegetal residues from the crops of peas, soy, wheat and corn.

The technologies referring to crop fertilization systems respect the conditions required by the national and international standards as they were established by the Nitrates Directive (91/676/EEC), Directive 86/278/EEC on the use of sewage sludge, Regulation (EC) no. 1881/2006 on the content of heavy metals in plants and seeds, (COM (2011) 244) and COM (2011) 450, for the protection of soils and biodiversity etc.

The studies on soil tillage systems presented in chapter 4 include the results obtained at the conventional tillage systems and at the ones with minimum soil tillage. The results indicate that the productions obtained at the minimum tillage system compared to the results of the conventional system were of 94-100% at the winter wheat, 85 – 100% at corn, 96-110% at soy and 94-98% at winter rape. The use of minimum tillage systems and vegetal residues according to the FAO 2012 regulations generated the improvement of soil's physical, chemical and biological characteristics. At the maize crops, the fertilizers were capitalized better when the tillage of the soil were made deeper (plough at 30 cm; cizel + disc) determined an increase of the production between 156 and 169 % (3970-4106 kg/ha) depending of the dose used.

Chapter 5 contains of the studies conducted on erosion processes in Moldova Plain and the methods for controlling them. It also includes a presentation of the ameliorative technology for the anti-erosion organization of fields and cropping systems on slope lands.

On the field where anti-erosion works were performed, the average soil losses by erosion diminished 28 years after being arranged compared to the unarranged surfaces, from 2.643 t/ha/year to 1.217 t/ha/year (54%). The research conducted on the methods of controlling soil erosion indicate that 28 years after arranging the sides with strips with grass and strip cropping, the water runoff was reduced compared to the unarranged surfaces by 38% and the soil losses decreased by 54%.

The annual average soil losses due to erosion recorded in Moldova Plain between 1986-2011 were of 0.234 t/ha at perennial grass in the second year of vegetation, 4.36 t/ha at beans, 7.82 t/ha at corn and 8.26 t/ha at sunflower. Recent estimations on soil erosion in EU-27 show that the affected surface is of 1.3 million km<sup>2</sup>, 20% of which recording soil losses of 10 t/ha/year; Directive COM (2011) 244 and COM (2011) 571 refer to a better integration of soil protection in CAP 2016-2020.

The studies in this field, as presented in the 5 chapters mentioned above, were oriented on the major interest of all countries to establish some effective technologies to increase soil production and protection against various types of degradation. The researches focused on studying the soil degradation processes due to erosion, acidification, compaction etc. and establishing the technologies to remedy them. The monitorization of the effectiveness of complex agrotechnical and pedoameliorative works were conducted using modern methods and equipment to analyse the physical and chemical features of the soil, using digital photogrammetry and the specific information systems.

The research activity was conducted in the field of Agrotechnics and Soil Erosion Control obtaining, by competition, all scientific grades from the title of Researcher in 1984, Senior Researcher III in 1987, Senior Researcher II 1992 and Senior Researcher I, in 1998.

Since 2005, when apart from the scientific activity I also started teaching I published 7 books, at 4 of them being the sole and first author, 9 works indexed in ISI Thomson quoted journals at 4 of them being the first author, 85 papers indexed in international databases and at 45 of them I was the first author, 26 papers at different international conferences and 24 papers at national conferences.

The studies conducted in the research projects gave the possibility of constantly updating the scientific database with results that contributed at the improvement of the following technologies:

-Technologies and crop systems to prevent physical, chemical and biological degradation on eroded slope land;

-Establishing the technical elements for the organization of the territory and of the cropping systems to improve the physical-chemical properties and decrease the infestation level with weeds, pathogens and pest of the soil;

-Technologies referring to soil tillage and fertilization systems in crop rotation that insure less fuel consumption and eliminating the risk of chemical pollution of the agricultural environment;

-Technologies for the integrated control of weed to limit its damages;

-Technologies for the soil tillage and fertilization systems for the new varieties and hybrids cultivated in the Moldova Plain;

-Assessing the degradation level of fields and establishing the technologies for controlling erosion, acidification, salinization, compaction and dehumification.

The international visibility of the results obtained and the impact of the published papers are marked by 44 citations in Web of Science, Hirsch index (h-index) 5, 50 citations in Scopus Preview, Hirsch index 5 and more than 105 citations in Google Scholar, Hirsch index – 8. Moreover, the scientific and professional activity is supported by the author's participation as moderator at the scientific symposium of USAMV Iasi, by the member status in the editorial board of the journal of Agronomical Research in Moldavia and Scientific Papers, Agronomy Series USAMV Iasi, by the status of scientific referee for PhD theses and organiser of three National Agrotechnical Conference.

The future scientific and professional activity will continue the research stated in the field of Agrotechnics, Soil Science, Soil Erosion Control, Environmental Protection and especially soil and water protection.

In the field of soil erosion control the research will be focused on assessing the degradation processes of land because of erosion and drawing up the methods for reducing the erosion processes and re-establishing soil fertility level. The future studies will contribute at improving the database and updating the information obtained previously to create new technologies and use them to answer the requests of the National Program of Rural Development 2016-2020. The investigations will continue identifying and assessing the soil degradation process to establish the protection measures and monitoring the influence of works on soil erosion as well as the impact of the agricultural and pedoameliorative works and land improvement on soil production and fertility and on the quality of water and soil.

At the end of the thesis I presented references related to the content of the first two sections.