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CONSEQUENCES OF FRAGMENTATION OF AGRICULTURAL LAND ARRANGEMENT WITH DRYING-DRAINAGE WORKS

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Abstract

Agriculture plays a strategic role in all countries, as it is the main sector responsible for food security of the population, while also making a special contribution to the overall process of sustainable economic development and environmental protection. Land improvement works, in all the states of the world, have a very important contribution in the food supply of the population. Despite the special agricultural potential of the lands in the meadow and terraces of the River Moldova, arranged with surface and subsurface drainage works, the deficient organization of this sector, after 1991, by the increased fragmentation of the agricultural lands, the exploitation on small plots located improperly compared to the network of absorbent channels and drains, the lack of advanced agricultural technologies, led to the practice of a subsistence agriculture, depending on the weather conditions. The modeling of the land inconsistent with the position of the absorbent drains and the network of canals favoured the stagnation of water in ditches and micro-depressions, the prolongation of excess moisture, which led to delays and improper performance of soil works and, implicitly, to low yields.

Key words: *surface and subsurface drainage, excess moisture, shaping in ridges and furrows, canal network.*

INTRODUCTION

Agricultural land and agricultural production are threatened by climate change mainly due to extreme variability in rainfall and temperature. Water shortages as well as stagnant water on the land surface have a negative impact on agricultural production, impact that can be reduced with the help of land improvement works (irrigation, surface drainage, deep drainage, combating soil erosion, etc.).

If properly operated, surface and subsurface drainage systems can serve as ample reservoirs to retain or release water and dissolved substances. Controlled drainage systems can be used to reduce agrochemical runoff from agricultural land and are valuable tools for flood prevention control (Bohne et al., 2012).

The drainage channels are ubiquitous features in the agricultural landscape. The design of two-stage canals demonstrates an increase in river stability, facilitates sediment deposition and creates important habitat characteristics. This management practice may be a viable option for addressing erosion issues, sediment imbalance and poor habitat in surface and subsurface drainage systems (Kalcic et al., 2018; Hodaj et al., 2017; Krider et al., 2017; Dunn et al., 2016; D'Ambrosio et al., 2015).

MATERIALS AND METHODS

The surface and subsurface drainage arrangements under study are located on the middle course of the Moldova river basin, belonging entirely to the extra-Carpathian region. The Moldova River Basin is located in the NE part of the Eastern Carpathians and in the NW of the Moldavian Plateau, being framed by the meridians 25º08'37″ - 26º58'35″ east longitude and by the parallels 46º55'37″ - 47º43'38″ north latitude.

The landscaped lands are part of the Falticeni Plateau (Somuzurilor Plateau), between the rivers Moldova, Somuzul Mare and Siret, which is a separate subunit of the Suceava Plateau. According to many authors, the area is included in the Subcarpathians, as an external unit of hilly piedmont. Some authors include this area on the Moldavian Plateau under the name of the Piedmont Plateau, which also includes the wide meadow of Moldova between Paltinoasa and up to Roman, called the Baia-Moldova-Roman Piedmont Plain.

From a climatic point of view, the river basin is part of the temperate continental continent of Eastern Europe, which also has some transitional features from some humid, oceanic and sub-Baltic shades in the upper course, to others more excessive in the lower course, to which is added the föehnization of the air masses descending on the eastern slopes of the Eastern Carpathians.

In order to eliminate excess water, improve the aerohydric regime of the soil and introduce these lands into the normal circuit of agricultural production, in order to capitalize on their full fertility potential, four surface and subsurface drainage systems were arranged in the meadow and terraces of the Moldova River, Suceava County, in the period 1978-1985 (Figure 1).

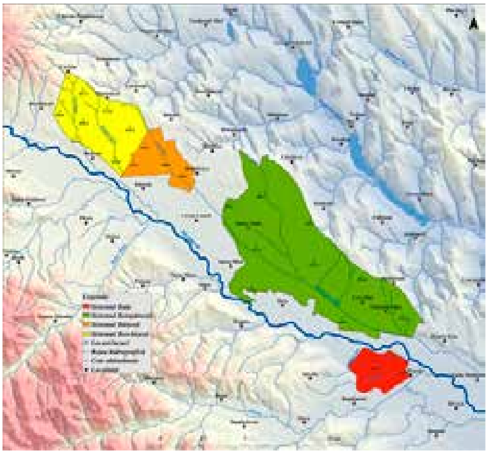

Figure 1. Surface and subsurface drainage arrangements in the Moldova river basin

The surface and subsurface drainage systems facilities cover a total area of 8761 ha, of which, on an area of 3059 ha, underground drainage works with pipes were carried out. The network of drainage canals with a total length of 126.85 km consists of collecting, evacuation, intercepting and other canals. In order to evacuate the excess water from the soil profile, according to the nature and intensity of the excess humidity, and the underground drainage network consisting of absorbent drains and collector drains, with a total length of 1575.12 km.

In order to highlight the behavior of surface and subsurface drainage systems following land fragmentation and exploitation on individual plots, field observations and topographic measurements were performed with the ROVER STONEX S7-G GPS, and the Auto-CAD Map 3D 2014 program was used for data processing.

The cartographic materials were obtained using TNTmips v.6.9 and QGIS. An important step in spatial modeling was the realization of the Numerical Terrain Model (MNT) by vectorizing contours and elevations on topographic maps at a scale of 1:25 000.

RESULTS AND DISCUSSIONS

The technical and improvement efficiency of the surface and subsurface drainage systems depends on the mode of exploitation of the arranged surfaces, the rigorous application of maintenance work and the rhythmicity and correctness of the work to accelerate the removal of excess moisture.

Surface and subsurface drainage systems have been designed to be operated on drainage sectors.

Hydro-improvement works, regardless of their complexity and intensity, cannot act directly on the entire surface in the sense of modifying or improving some physical properties, unfavorable chemical and biological conditions of the soils, in relation to the requirements of growth and development of agricultural crops.

In this regard, in order to raise their production capacity to the optimum level needed productively, on the lands arranged from the Moldova river meadow, the hydro-amelioration works were applied in complex with the agro-amelioration works (leveling, modeling, deep loosening, calcium fine, etc.).

By applying the Land Fund Law no. 18/1991, for the constitution and reconstitution of the property right, the conditions for the exploitation of the drained surfaces have changed. The reconstitution of the property right, as a rule, on the old site determined the different orientation of the plots towards the network of canals and / or the absorbent drain lines (Figure 2).

The individual exploitation of the plots of land and, in particular, the mouldboard ploughing determined, over time, modeling the land in ridge strips, with widths, level differences and transverse slopes varying depending on the width of the plots, the way of use and the equipment used for the application of agricultural works.

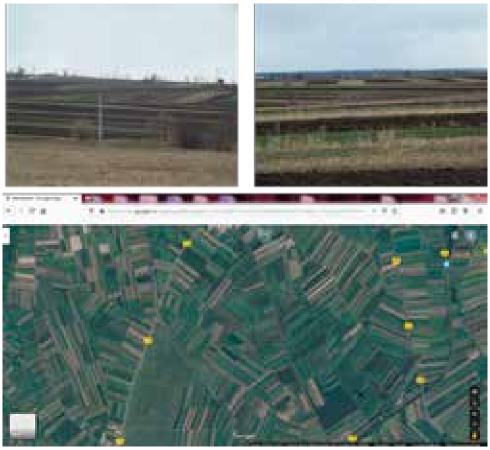

Figure 2. Individual exploitation of plots of land

The land shaping in ridges and furrows was provided in the projects for the execution of surface and subsurface drainage systems as a measure to accelerate the elimination of excess water. For the effectiveness of this measure, in the case of the drained surface, the gutters must be located above the absorbent drain lines, and in the case of the drainage surface they must be oriented on the line of the highest slope and perpendicular to the network of channels.

In order to highlight the influence of the orientation of the plots and, implicitly, of the land shaping in ridges and furrows, as a result of the individual performance of the soil works, on the elimination of the excess water, an area of 62 700 m^2 was studied, from the surface and subsurface drainage system Dragoiesti-Berchisesti, arranged only with drainage works. Topographic measurements were performed on several alignments, transversely on the plots, the topographic points being established at the boundary between the plots (gutters) and on the formed ridges. Figure 3 shows the position of the topographic points on the transverse profiles made on the plots and their elevations, determined in the Black Sea-1975 reference system.

In order to highlight the orientation of the plots on the surface arranged only with drainage works, in Figure 4 and 5 the level curves with the natural equidistance of 0.5 m and the 3D model of the land surface are shown. The analysis of the figure shows that the 15 plots on the NW side are oriented on the line of the highest slope and the 14 plots on the SE side are oriented approximately along the level curves.

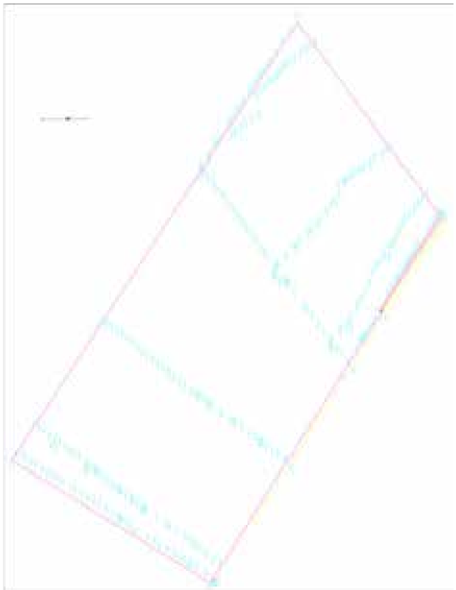

Figure 3. Topographic plan with dimensioned points

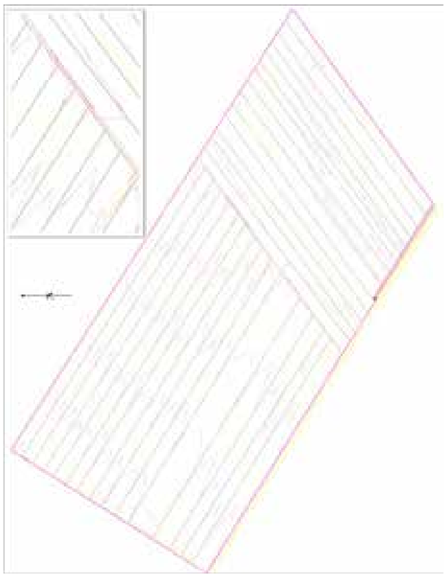

Figure 4. Topo-cadastral plan with level curves

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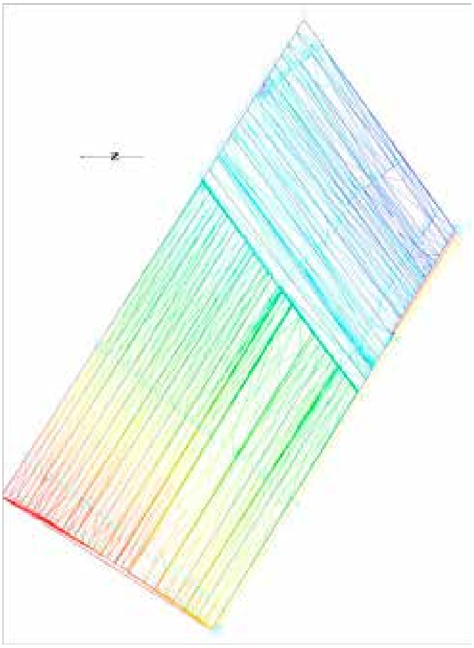

Figure 5. Topo-cadastral plan in the 3D representation system

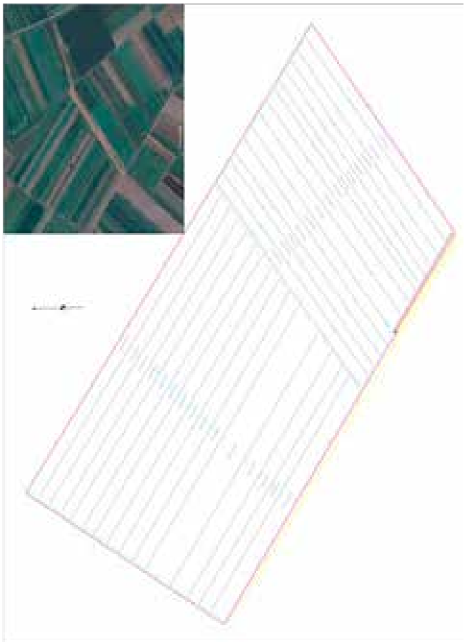

Figure 6. Dimensions of individual plots of land

The analysis of the size of the plots in Figure 6 reflects their relatively small dimensions, both in terms of area and especially width. For plots oriented perpendicular to the level curves, the smallest has an area of 1867.340 m^2 and an average width of 9.50 m, and the largest has 4927.315 m^2 and a width of about 23.00 m. At the plots oriented approximately parallel to the level curves, the smallest has 1071.412 m^2 and an average width of 6.00 m, and the largest has 2104.938 m^2 and an average width of 12.00 m. From the route of the level curves presented in figure 4 results the land shaping in ridges and furrows on the individual plots of land, the ditches being located at the boundary between the properties. This modeling is the result of the individual performance of the soil works, in particular, the mouldboard ploughing, which is generalized in this area, through the gutters being materialized the boundary between the properties. The formation of ridge-shaped modeling as a result, mainly, of the execution of plowing on the ridge also results from the transversal profile made on 5 plots oriented on the line of the highest slope, exploited as arable, with widths between 10.54 m an 23.34 m (Figure 7).

Level differences between ditches and ridges resulting from soil work, determined at the time of measurements, they have values between 0.24 and 0.67 m, with an average of 0.48 m. At the limit between the first four plots, the formation of ditches is observed, with a triangular section, formed after plowing, with variable dimensions depending on the agricultural equipment used and the working depth. The opening of the gutters between the first three plots is about 2.00 m and have depths between 0.30-0.45 m.

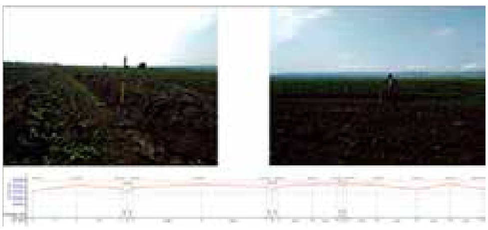

Figure 7. Transverse profile through the plots oriented on the line of the highest slope

The gutter formed between plot three and four has smaller dimensions, the opening is about 1.40 m and the depth is 0.24 m. From the form of modeling plots three and four, it can be

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deduced that on these two plots, in the previous years, the basic works of the soil were carried out in combination, by plowing the mouldboard. From this it can be concluded that the geometric elements of the land modeling in ridge strips depend on the width of the plots, the agricultural machinery used to perform the basic work of the soil, the direction of return of the furrow and the number of years used. The land shaping in ridges and furrows, on the plots oriented perpendicular to the level curves, favors the drainage of the excess water in the periods with abundant precipitations. However, these leaks are obstructed, downstream, by the modeling of the plots oriented approximately parallel to the level curves and remain confined in their gutters (Figure 8).

Figure 8. Drainage and cantonment of water caused by shaping in ridges and furrows

The evacuation of the excess water, coming from precipitations, towards the collector channel of the bordering sector, in the SW part of the plots oriented along the level curves, is also hindered by the higher elevation of the land at the end of the plots towards their middle. The prolongation of the excess humidity in this area is also due to the fact that some of the canals have been blocked and introduced in the agricultural circuit, and the sector collector channel adjacent to the plots has a high degree of clogging, accelerated by facilitating owners' access to plots and vegetation wood intensely developed on some sections. Stagnation of water and prolongation of excess moisture for a long period of time, especially in spring, delay the spring work and the establishment of crops, as well as the delay and improper performance of maintenance work (Figure 9).

The prolongation of the excess water, the delay and the improper performance of the soil works, implicitly the obtaining of small productions, determined the landowners to give up, year by year, on a part of the surfaces where the excess is manifested, using as arable only the higher areas from where the excess water is removed in a shorter interval.

Figure 9. Clogging of ducts and prolongation of excess moisture

Thus, most of the individual plots oriented approximately parallel to the level curves, with arable use, are no longer capitalized on their entire productive capacity, they have passed, one by one, to the hay exploitation mode (Figure 10).

Figure 10. Changing the exploitation of the arranged lands

On these lands exploited as hay, due to the reappearance of excess moisture, the floristic composition is inferior, the hygrophilous vegetation predominates and the fodder productions obtained are of poor quality, with low nutritional value.

In recent years, the increase in interest in agricultural land, with the granting of subsidies and verification through the Integrated Administration and Control System carried out by APIA, it was found that the landowners tried to reinsertion these areas into the arable circuit. However, in the absence of canal network rehabilitation works and works to accelerate the removal of excess water, especially leveling, reintroduction to arable land is not completed, agricultural works being limited by the same restrictive factor, namely excess moisture (Figure 11).

Figure 11. Arable reintroduction attempt

Although the soils in the surface and subsurface drainage systems have a high productive potential, the agricultural production is significantly diminished by the exploitation of the lands on the individual plots. Production losses are directly correlated with the prolongation of excess water, the delay in the application of agricultural works and the impossibility of applying agricultural technologies due to the small width of individual plots of land.

CONCLUSIONS

The excess moisture lands have been arranged with surface and subsurface drainage works to be exploited on drainage sectors.
The capitalization of the entire productive potential of these lands is ensured by the rigorous and rhythmic application of the works of acceleration of the elimination of the excess of water and of the maintenance ones.
Reconstitution of the property right as a result of the application of the Land Fund Law no. 18/1991 and the subsequent laws, as a rule, on the old sites, determined a strong fragmentation of the arranged lands.
The individual exploitation of the plots of land and, in particular, the performance of the basic work, determined the land shaping in ridges and furrows, with widths, level differences and variable transverse slopes, depending on the width of the plots, how to use and the equipment used for the application of agricultural works.
Landscaping inconsistent with the canal network favours stagnant water on the gutters between plots of land and prolonging excess moisture.
The prolongation of the excess water, the delay and the improper performance of the soil works, implicitly, the obtaining of small productions, led to the renunciation of the exploitation as arable of these plots of land and the gradual transition to the use of hay.
The excess of humidity determined a lower floristic composition of the hayfields, the hygrophilous vegetation predominating and the obtained fodder productions are of poor quality, with low nutritional value.
The production losses are in direct correlation with the width of the plots, the duration of the stagnant water in the gutters, implicitly, the delay in the application of agricultural works and the impossibility of applying modern technologies due to the small width of the individual plots of land.

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