# QUALITY INDEX ESTABLISHMENT AND EVALUATION OF AGRICULTURAL LAND IN THE MĂDÂRJAC ADMINISTRATIVE-TERRITORIAL UNIT, IASI COUNTY

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**ABSTRACT**

*The quality of agricultural land is determined by the quality index, based on which the agricultural land in Romania is classified into five quality classes, differentiated by the quality index grade. 27 simple soil units and 7 complex soil units have been identified in the territory considered in this study that have been divided by slope and array in 153 elementary units of land, homogeneous in terms of all features (TEO).*

*Based on quality index calculated grades on the 153 environmentally homogeneous territories, it has been established that the mapped land falls under II, III, IV and V classes of quality for agricultural use. Out of the total mapped area of 1369 ha, the most part falls under the III class of quality (37%), 58% under IV and V class and only 5% under II class.*

*The share of land in the lower classes of quality shows a reduced productive capacity and, implicitly, a lower value of land in this area.*

***Keywords:*** *soil units, agricultural land quality assessment, the quality classes, indicators of evaluation*

## 1. Introduction

In its capacity of primary natural resource for agriculture, the soil is a basic constituent of the continuity and prosperity of rural inhabitants, and hence of the prosperity of the entire nation, which compels us to preserve and make the best use of this natural capital. Soils are the most valuable wealth, the most precious asset, which needs to be known and acknowledged, preserved and used at its real potential (Acad. Cristian HERA, 2008).

The rational exploitation of soil resources requires an intimate knowledge of soil properties, but also of the features of all the environmental factors.

The harmful effect of soil quality as a consequence of the negative influence of the factors regarding the climate, relief, hydrology, soil characteristics has been assessed under various intensities over 7.5 million ha of arable land, which represents around 80% of the arable surface of Romania (Dumitru M. and collab., 2006).

Teaci D. et al. (1985), defines agricultural land quality assessment as the "complex operation of thorough knowledge of plant growth and fructification conditions and the determination of the favorability of these conditions for each use and crop, by means of a system of technical indices and assessment grades."

The value of crops and the net cadastre revenue, for long periods of time, may be determined scientifically by cadastre assessment methods applied to agricultural land, thus preventing the undesirable consequences of approximations relying on uncertain data.

## 2. Material and method

From the administrative point of view, Mădârjac Commune is in Iaşi County, being located about 50-60 km south-east of Iaşi City, and from the geographic point of view, it lies in the north of the Central Moldavian Plateau. Mădârjac Commune lies in a hilly and plateau area, in the middle of a woody massif of over 15,000 ha. It actually looks more like a big clearing surrounded by woods.

From a geological perspective, Mădârjac village is located within the large area of the Moldavian Platform, from the sedimentary layer of which the fluvial and denudation processes have brought up to date Basarab structures (the average Sarmatian), which presents a slight declivity of around 7-8 m/km in the direction NNW-SSE (Jeanrenaud P., 1961, 1965, 1971; Jeanrenaud P., Saraiman A., 1995; Ionesi L. et al, 1995), composed of clays and sandy clays with sand interlayer over which there are coarser formations, deposited in neritic and coastline facies, of which comes apart the reference horizon of the Repedea freestone and of the Şcheia sandstone.

The total area of Mădârjac territorial and administrative unit is 5263 ha, of which 1329 ha make up the agricultural area and 3934 ha the non-agricultural area. According to land uses, one may distinguish among the following categories: 559 ha of arable land, 434 ha of grazing land, 304 ha of grass land, 27 ha of vineyards, 5 ha of orchards, 3736 ha of woods, 18 ha of waters, 62 ha of roads, 111 ha of courtyards and buildings and 7 ha of barrens.

A pedological survey carried out by O.S.P.A Iaşi, on a 1:10,000 scale, was used and uniformly processed for the stocktaking and morphological characterization of the soil cover. The soil map was scanned and georeferenced by correspondence, then the soil units were vectorized and corrected according to the Digital Terrain Model. Thus, in the end, we outlined 110 polygons depicting simple soil units, complex soil units and other uses. As we dealt with an older pedological study, we needed to equate the types of soil in the Romanian Soil Classification System created in 2003 with the soils in the Romanian Soil Taxonomy System published in 2012.

The assessment of the evaluation coefficients on different intensity degrees of the soil degradation factors, the evaluation and arrangement of the fields according to quality classes, for arable usage, were performed according to the "Methodology for Drafting the Soil Studies" part II, I.C.P.A. Bucharest-1987, by using BDUST software, version 9.5.

The cartographic material was collected by using the TNTmips v.6.9 and ArcGIS v.10.1 programs. An important stage in spatial modeling was the development of the Digital Terrain Model (DTM), by the vectorization of the contour lines on the topographic plans at a 1:25,000 scale. Thematic maps on hypsometry, land slope gradient and exposure, shading, etc. were created based on vectorized contour line processing.

## 3. Results and discussions

Since the production capacity of the fields modifies under the influence of the natural factors, but mostly because of the human intervention, the evaluation must be updated on a permanent basis.

Based on the soil mapping of the agricultural land in Mădârjac territorial and administrative division, there are 27 simple soil units and 7 complex soil units (composed of 17 simple soil units), belonging to the following soil classes: Protisoils, Cernisoils, Luvisolic soils, Hidrisoils and Antrisoils (Fig. 1). The Protisoil class comprises 8 soil units, US 1,…, US 8, the Cernisoil class comprises US 9 soil unit, the Luvisolic soils class comprises 14 units, US 10,…, US 23, the Hidrisoil and Antrisoil classes comprise two soil units each, US

24, US 25 and respectively, US 26 and US 27. On the surfaces with stabilized landslides, the US 701 and US 702 complex soil units were delimited, on the semi-stabilized ones, the US 704 complex soil unit was delimited, on the active landslides - US 705 and US 706 and on ravines – the US 707 complex soil unit. The main factors regarding the soil, relief, climate and vegetation conditioned the zonal multi-stage structure of the soils in the investigated area.

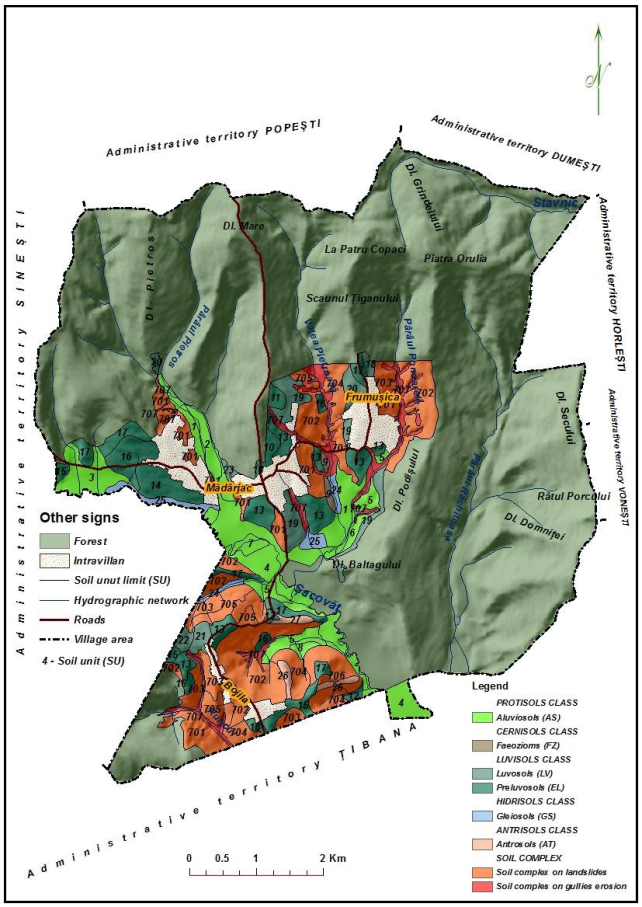
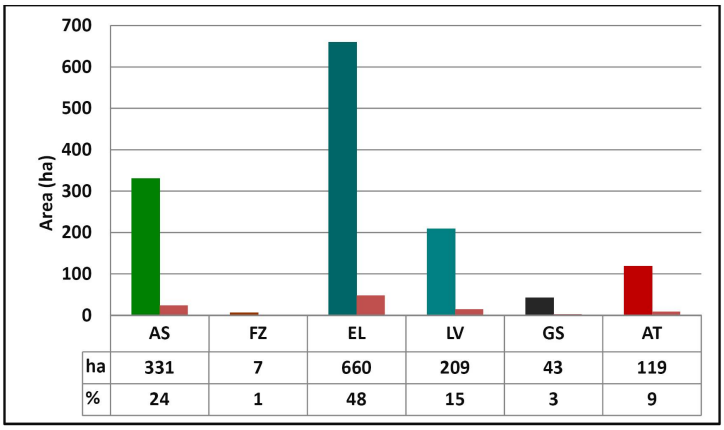



Figure 1 Soil Units Charts (US)

From a geomorphologic perspective, characteristic to the slopes of the Central Moldavian Tableland, 63% of the soil mapped surface is occupied by preluvosoils and luvisolic soils and 9% by anthrosoils, most of them being erosion and preludic sub types, and the narrow plains and valleys are occupied by alluvial soils (24%) and gleysoils (3%) (Fig. 2). The phaeozems occupy a narrow surface of 7 ha, that is less than 1% of the soil mapped surface of 1369 ha.

The identified soil units were divided, according to the cliff and view, into elementary field units, homogenous from the perspective of all the soil and field features, called ecological homogeneous territories (TEO's). The ecological homogeneous territory represents the basic unit for which the bonitation grades, the quality classes, the favorability classes, the reliability classes, etc. are calculated, based on the indicators.

The field declivity chart (Fig. 3) and the field view chart (Fig. 4), highlight the consequent/re-consequent nature of the valleys, fragmenting the slope reversed massif, with general Southern view, on which the territory of Mădârjac village is set.




| | AS | FZ | EL | LV | GS | AT |
|---|---|---|---|---|---|---|
| ha | 331 | 7 | 660 | 209 | 43 | 119 |
| % | 24 | 1 | 48 | 15 | 3 | 9 |

Figure 2 Soil types weight

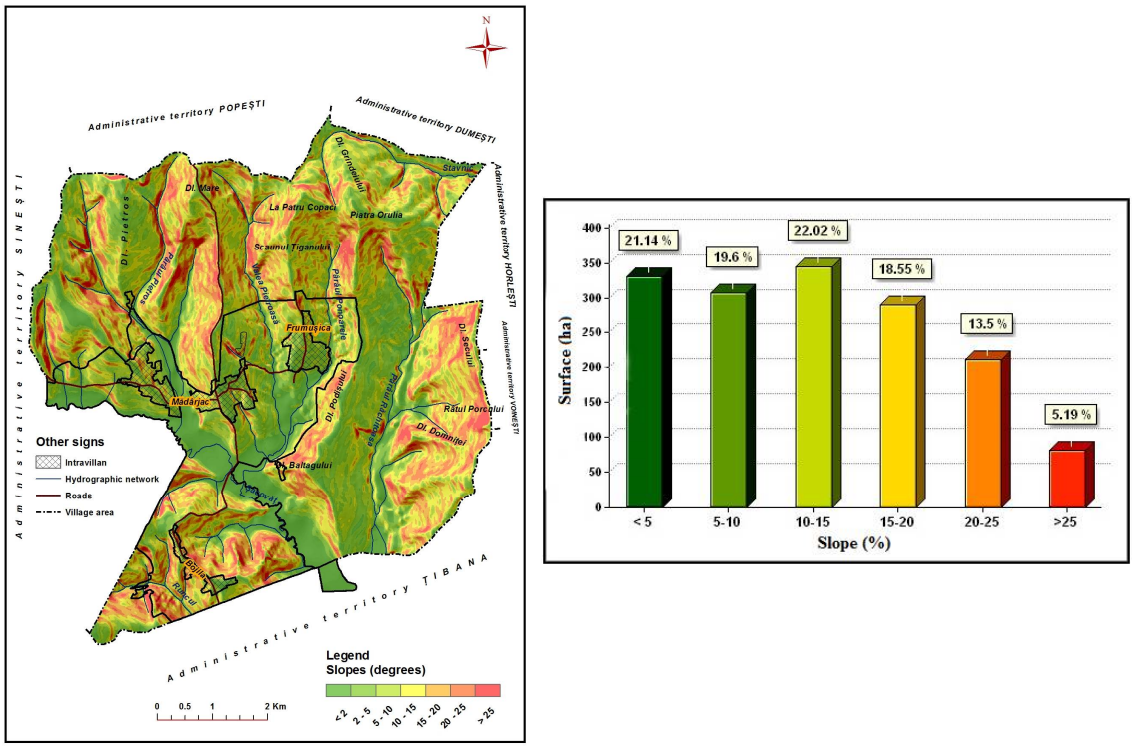



Figure 3 Field declivity chart and slopes weight

By analyzing Figure 3, we can notice that from the soil mapped surface (1369 ha) plus the incorporated areas of the localities (196 ha), the surface of 331.04 ha (21.14%) presents declivities smaller than 5%, 651.64 ha (41.62%) presents declivities between 5-15%, 501.70 ha (32.05%) has declivities between 15-25% and declivities higher than 25% register on a surface of 81.24 ha, representing 5.19% of the total surface.

Figure 4 shows that, within the mapped territory, the S, SE and SW views have the highest weight, with a total percentage of 41.84%, the E view occupies 16.06%, the W view occupies 14.63% and the N, NE and NW views occupy a percentage of 27.47% of the surface.

As a consequence of this fragmentation of the field, a number of 153 simple and complex TEO's resulted on the mapped territory, at the level of which we performed the

computing of the bonitation grades, according to cultures and usages, for natural conditions, on the studied territory there being no arrangement and amelioration work of the fields. For that purpose, we extracted the coefficients corresponding to the bonitation indicators in the Methodology for Drafting the Soil Studies- part II, drafted by the I.C.P.A. Bucharest, in 1987, Annexes 3-2,…, 3-18.

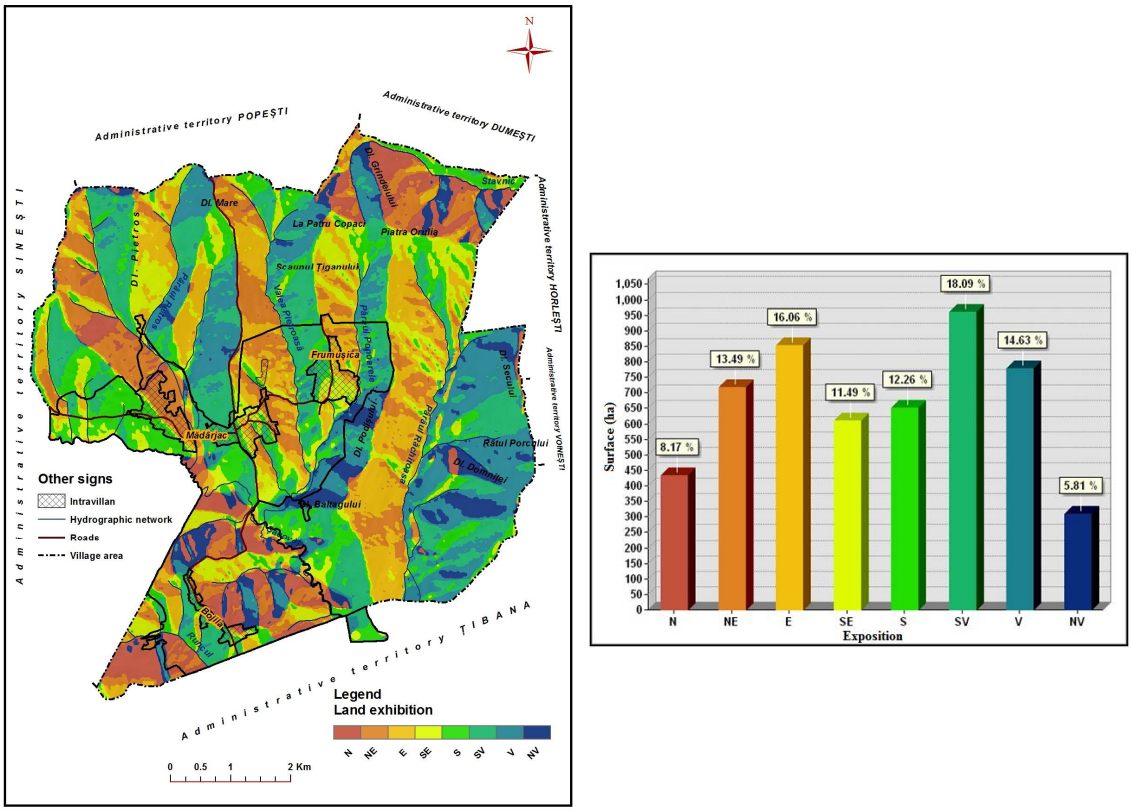



Figure 4 - Field view chart and weight

Of the 17 indicators which participate in a direct manner in the settlement of the bonitation grade, gleying (indicator 14) and stagnogleying (indicator 15), represent limitative essential factors in determining the quality classes of the soils from Mădârjac village. Therefore, the slight gleying present on 238 ha (17%), of the soil mapped surface, does not penalize the 8 cultures (wheat, barley, corn, sunflower, potato, sugar beet, soya and peas/beans), taken into consideration when determining the average grade for the arable usage, but the strong gleying on 93 ha (7%) and the excessive one present on 43 ha (3%), penalize the aforementioned cultures with 0.1-0.3 points, being a disadvantageous feature, mainly the excessive gleying.

The slight excess of stagnant humidity which affects 584 ha (43%), of the soil mapped surface, does not have a negative influence on the favorability of the eight investigated cultures, as compared to the moderate – strong stagnogleying, occupying 302 ha (22%) and which represents an unfavorable limitative indicator, mainly the strong stagnogleying, penalizing with 0.5 points the potato and with 0.4 points the sugar beet, and the other cultures with 0.2-0.3 points.

Field declivity is another important indicator in determining the bonitation grades of the fields in Mădârjac village, the presence of these declivities diminishes the favorability of the respective surfaces, favoring soil erosion, affecting other properties of the soil.

By analyzing the bonitation coefficients for the declivity of the field, according to the Bonitation Methodology of the Agricultural Fields, we can notice that they vary within very large limits, according to the declivity. Therefore, for the declivities up to 10%, the annual plants which can be bred and the vegetables are slightly penalized with 0.1 points, while straw cereals bear well this declivity of the fields.

Once with plants growth, the eight cultures taken into account become more and more sensitive to the declivity of the fields, so that the declivities of more than 25% are penalized with 0.7-0.9 points.

Moreover, landslides presence penalizes the cultures according to the type and intensity of the sliding phenomena.

The stabilized landslides occupying a surface of 374 ha, representing 27% of the soil mapped surface (1369 ha), can be successfully used for the straw cereals culture by enforcing the appropriate agricultural soil ameliorative works, penalizing them with 0.2 points only, but these are less recommended for the potato and sugar beet cultures, penalized with 0.4 points.

The fields affected by semi-active, active landslides and ravines occupying 239 ha, namely 17% of the soil mapped surface are completely contraindicated for agricultural plants culture.

The bonitation grade for natural conditions, according to usages and cultures, was achieved by multiplying by 100 the product of the coefficients of the 17 indicators, which participate in a direct manner in the determination of the bonitation grade.

$$\mathbf{Y = (x_1 \cdot x_2 \cdot x_3 \cdot ... \cdot x_{17}) \cdot 100}$$

where: Y – is the bonitation grade, according to the usage or culture;

$x_1$, $x_2$, $x_3$, ..., $x_{17}$ – represent the coefficients for the bonitation indicators.

For the arable usage, the bonitation grade was computed by observing the regulations in force, as the arithmetic mean of the grades of the 8 most disseminated cultures (wheat, barley, corn, sunflower, potato, sugar beet, soya and peas/beans).

At the soil units' level, the bonitation grade was computed as weighted average of the bonitation grades corresponding to the ecological homogeneous territories comprised.

Based on the obtained bonitation grades, the result is that the mapped surface of 1369 ha of the Mădârjac territorial and administrative division, of Ia□i county, frames within the II-nd, III-rd, IV-th and V-th quality classes, for the arable usage category.

Table 1 presents the bonitation grades and the quality classes, for the arable usage, on the 27 simple soil units and the 7 complex soil units.

By analyzing Table 1, we can notice that, the II-nd quality class comprises, in decreasing order of the bonitation grades obtained, for the arable usage, the US 1, US 8 (Protisoils), US 10 (Luvisolic soils) and US 9 (Cernisoils) soil units. The V-th quality class comprises US 24 and US 25 of Hidrisoil class and the US 704, US 705, US 706 and US 707 complex soil units. The highest bonitation grade for arable usage resulted at the US 1 soil unit, having a surface of 42 ha, with 75 bonitation points, and the lowest grades were obtained for the soil complexes located on semi-stabilized and active landslides, with 12 points and on ravines, with the bonitation grade of 7 points.

Because of the geomorphologic indicators within the Mădârjac territorial and administrative division, consisting of pronounced declivity, landslides, deep erosion (ravines), but also of the morpho-physical-chemical analysis of the fields, regarding the content with very poor organic matter, moderately-strongly acid soil reaction, the texture of the clayey - heavy soils or interchangeable ones in the case of landslides, gleying and strong

stagnogleying, the largest surface (532 ha) frames within the III-rd quality class, representing 39% of the soil mapped surface (Fig. 5).

Table 1 – The bonitation grades and the quality classes, according to soil units, for arable usage

| Nr. crt. | US | Surf. (ha) | The bonitation grad | The quality class | Nr. crt. | US | Surf. (ha) | The bonitation grad | The quality class |
|---|---|---|---|---|---|---|---|---|---|
| 1 | **1** | **42** | **75** | **II** | 18 | **18** | **4** | **52** | **III** |
| 2 | **2** | **34** | **58** | **III** | 19 | **19** | **57** | **44** | **III** |
| 3 | **3** | **44** | **59** | **III** | 20 | **20** | **16** | **58** | **III** |
| 4 | **4** | **146** | **50** | **III** | 21 | **21** | **11** | **35** | **IV** |
| 5 | **5** | **41** | **50** | **III** | 22 | **22** | **7** | **31** | **IV** |
| 6 | **6** | **9** | **50** | **III** | 23 | **23** | **4** | **35** | **IV** |
| 7 | **7** | **10** | **28** | **IV** | 24 | **24** | **11** | **15** | **V** |
| 8 | **8** | **5** | **70** | **II** | 25 | **25** | **23** | **15** | **V** |
| 9 | **9** | **7** | **62** | **II** | 26 | **26** | **12** | **25** | **IV** |
| 10 | **10** | **9** | **63** | **II** | 27 | **27** | **6** | **25** | **IV** |
| 11 | **11** | **7** | **48** | **III** | 28 | **701** | **108** | **34** | **IV** |
| 12 | **12** | **4** | **48** | **III** | 29 | **702** | **209** | **27** | **IV** |
| 13 | **13** | **89** | **47** | **III** | 30 | **703** | **58** | **28** | **IV** |
| 14 | **14** | **34** | **43** | **III** | 31 | **704** | **58** | **12** | **V** |
| 15 | **15** | **23** | **28** | **IV** | 32 | **705** | **48** | **12** | **V** |
| 16 | **16** | **47** | **43** | **III** | 33 | **706** | **44** | **12** | **V** |
| 17 | **17** | **51** | **35** | **IV** | 34 | **707** | **91** | **7** | **V** |

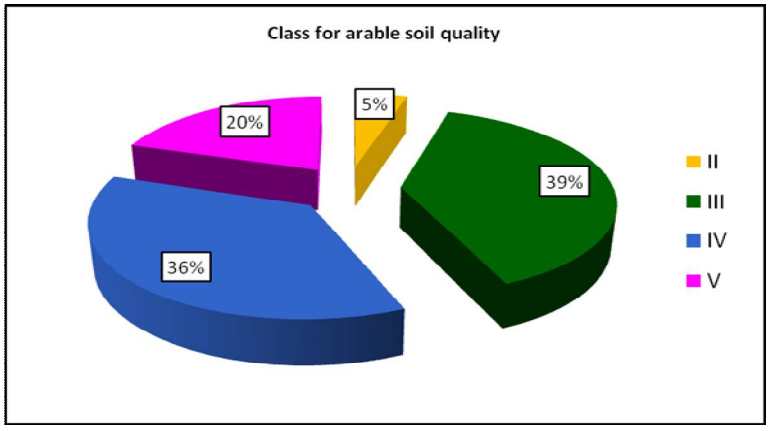



Figure 5 - Agricultural fields framing within quality classes

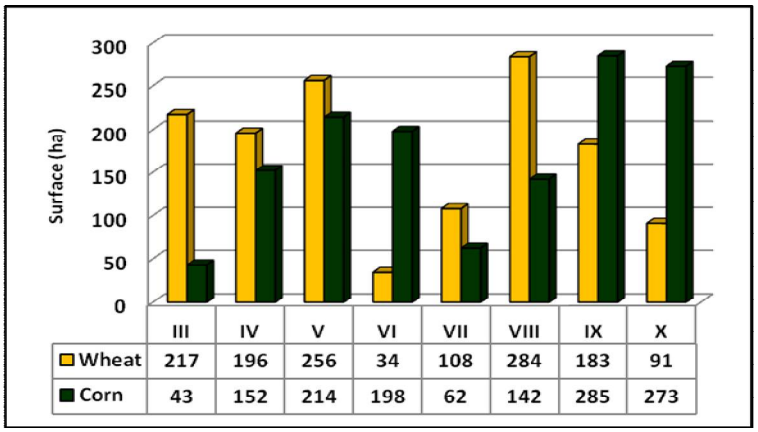
We must notice that more than a half of the mapped area, respectively 774 ha (56%), belong to the lower quality classes, the IV-th and the V-th ones.

The superior quality class, the II-nd one, comprises 63 ha only, which represents around 5%. The average texture, the relatively plain relief and the content full of organic matter are soil geomorphologic features raising the fertility degree of these soils.

The low quality of the agricultural fields in Mădârjac village is also highlighted by the weighted average on the total mapped surface of 1369 ha, for arable usage, having the value of 35.42 bonitation points, which frames this surface within the IV-th quality class.

Moreover, the surface with arable usage of 559 ha of Mădârjac village frames within the II-nd, III-rd, IV-th and V-th quality class. Therefore, the II-nd quality class comprises the smaller surface, of 34 ha (6.08%), the III-rd comprises the largest surface, having the value of 260 ha (46.51%), the IV-th quality class comprises the surface of 162 ha (28.98%) and the V-th class comprises the surface of 103 ha (18.43%).

Taking into account the two cultures, of wheat and corn, the most disseminated in the area, we can notice that they frame into the III-rd-X-th favorability classes, having bonitation grades between 1-80 points (Fig. 6).




| | III | IV | V | VI | VII | VIII | IX | X |
|---|---|---|---|---|---|---|---|---|
| Wheat | 217 | 196 | 256 | 34 | 108 | 284 | 183 | 91 |
| Corn | 43 | 152 | 214 | 198 | 62 | 142 | 285 | 273 |

Figure 6 - Favorability of the agricultural fields for the wheat and corn cultures

The fields meet more favorable conditions for wheat culture as compared to the corn; being a plant which has to be bred, it is penalized, mainly, by the high degree of declivity of the field.

The specialty literature supports the procurement of certain positive values of the net income per hectare, for the following bonitation grades intervals: 55-100 points for the wheat and 50-100 points for the corn.

Figure 6 shows that the III-rd-V-th favorability classes comprise 669 ha for wheat culture, representing 48.87% of the soil mapped surface, and 409 ha for corn culture, representing 29.88% of the surface.

The value of the agricultural field outside of the build-up area can be expressed, based on the profit, according to the value of the agricultural production minus the production expenditures, taking into account a certain number of exploitation years of the field, as follows:

**Vt = [Vp-(Cp + K1 + K2 + K3 + K4 + K5)] x N years,** where:

**Vt** – value of the agricultural field outside the build-up area, in lei/ha;
**Vp** – production value (main + secondary + allowances from the technological load);
**Cp** – general production expenditures;
**K1** – coefficient added to the production expenditures for the fields with declivities higher than 5% (K1 = 5% of the Cp);
**K2** – coefficient added to the production expenditures for the fields with declivities higher than 12% (K2 = 10% of the Cp);

**K3** – coefficient added to the production expenditures according to the distance up to the incorporated area (1% of the Cp for each km exceeding the limit of 2 km from the limit of the incorporated area);
**K4** – coefficient added to the production expenditures, depending on the access point (5 % of the Cp for the fields which are not bordered by a modernized road, practicable in all seasons);
**K5** – coefficient added to the production expenditures for the fields having a declivity of more than 6% and the length of the longest side below 300 m (5% of the Cp);
**N –** number of years of the agricultural exploitation: 25-30.

**Vp = NB (wheat) x kg/point x price lei/kg,** where:

NB (wheat) – bonitation grade for the wheat;
Kg/point – the equivalent in agricultural products of a bonitation point, according to Annex 1 of the Order no. 26/1994, of the Ministry of Agriculture, Food and Forestry, for wheat = 40 kg/bonitation point, considered as reference product;
Updated valorization price of the wheat (lei/kg)

General production expenditures, for which the values of the K1, …, K5 coefficients were taken into consideration, represented 85% of the production value:

$$Cp = Vp \times 85\%$$

The value of the agricultural field outside the build-up area was obtained as follows:

$$Vt = (Vp - Cp) \times N$$

From a practical point of view, this method is the most frequently used, because the obtained results are reasoned, mainly, by the average bonitation grade of the field for wheat culture, considered as a reference product.

Taking into account the weighted average grade for wheat culture, of 44 bonitation points, for the mapped surface of 1369 ha, the number of years of 25, 40 kg/bonitation point and wheat price in 2012 of 0.80 lei/kg, the result was:

**Vp = NB (wheat) x kg/point x price lei/kg = 44 x 40 x 0.80 = 1408 lei/ha**
**Cp = Vp x 85% = 1408 x 85% = 1196.80 lei/ha**
**Vt = (Vp – Cp) x N = (1408 – 1196.80) x 25 = 5280 lei/ha**

In 2014, the price of the wheat being of 0.50 lei/kg, we obtained:

**Vp = NB (wheat) x kg/point x price lei/kg = 44 x 40 x 0.50 = 880 lei/ha**
**Cp = Vp x 85% = 880 x 85% = 748 lei/ha**
**Vt = (Vp – Cp) x N = (880 – 748) x 25 = 3300 lei/ha**

For a correct assessment of the agricultural fields it is recommended to use the average selling prices of the agricultural products on different markets and destinations, and to evaluate the economic results of the cultures over a longer period (4-5 years).

## 4. Conclusions

In the mapped territory there were 27 simple soil units and 7 complex soil units, belonging to the classes: Protisoils, Cernisoils, Luvisolic soils, Hidrisoils and Antrisoils. The preluvosoils and luvosoils occupy 63% of the soil mapped surface, the alluvial soils 24%, the anthrosoils 9%, the gleysoils 3% and the phaeozem soils 1%.

The fragmented territory of Mădârjac village determined the delineation within the soil units, according to the declivity and view, of 153 ecological homogeneous territories (TEO), at the level of which we performed the computation of the bonitation grades for natural conditions, according to usages and cultures.

Within the soil geomorphologic conditions in the area, the bonitation indicators penalizing in a considerable manner the bonitation grades, according to usages and cultures, are: the gleying, the stagnogleying, the declivity of the field and the landslides.

Based on the bonitation grades computed at the level of the soil units as weighted average of the grades corresponding to the ecological homogeneous territories comprised, resulted that the territory of Mădârjac village frames into the arable usage category, within the II-nd, III-rd, IV-th and V-th quality class. Of the total mapped surface of 1369 ha, most of it frames within the III-rd quality class (39%), 56% framing within the IV-th and the V-th class and 5% only in the II-nd quality class.

The weighted average grade on the total mapped surface of 1369 ha, for arable usage, is of 35.42 bonitation points, which frames the agricultural fields within the IV-th quality class.

The surface of 559 ha, having the current usage of arable field, framing within the II-nd (6.08%), III-rd (46.51%), IV-th (28.98%) and V-th quality classes (18.43%).

Wheat and corn cultures frame within the III-rd-X-th favorability classes, the wheat meeting more favorable conditions as compared to the corn.

For a correct assessment of the agricultural fields it is recommended to use the average selling prices of the agricultural products on different markets and destinations and to evaluate the economic results of the cultures over a longer period (4-5 years).

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