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THE INFLUENCE OF LAND STRUCTURE ON PERFORMANCE OF WHEAT PRODUCTION. THE CASE OF THE ROMANIAN COUNTIES – CHALLENGING THE CHANGES

Abstract. *The territory of Romania presents a high diversity of ecological conditions determined by the variability of the atmospheric and edaphic factors, which strongly influence the agricultural production. Due to increasing land use pressures, soil quality assessment studies have been undertaken over time to fuel the increase in crop productivity concomitantly with the development of good agricultural practices. The local wheat crop is predominantly covered by native varieties, obtained by the Romanian researchers. The main use of wheat is represented by the production of bakery, and the quality of the final product is directly influenced by the physicochemical of the raw materials. Unlike most scientific studies that assess the yields according to soil quality, this paper identifies the suitable areas for wheat cultivation according to the quality of the product, the productivity per hectare and the average price of the production, using principal component analysis and clustering techniques.*

Keywords: *quality, soil, food safety, wheat, performance, zoning, aggregate indicator.*

JEL Classification: **O13, O52, Q18**

1. Introduction

According to the European Union and the World Health Organization, the food safety has a broader meaning resulting in multiple responsibilities that derive from crop yield and the resources exploited by it. Food is the regulator of the processes of exchange between the organism and the environment (Micu and Petanec, 2008). The Romanian territory includes the majority of soil types on the continent, and the climate includes all four seasons (Romania is crossed by the 45th Parallel). As a result, the food sources are diversified and the human health depends directly on its quality. Moreover, it is clear that food quality is influenced

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by both internal factors (physico-chemical composition, biological properties) and external factors (handling demands, storage environment, time, etc.).

Grain yield, productivity and land use have changed over time and their influence on the economic human development is obvious. Global cereal production has increased during 1961-2014 by 280%. Analyzing this evolution in correlation with the increase of the total population, which evolved by 136% over the same period, it is noticed that the global cereal production grew much faster than the population. Unfortunately this is not distributed equally, and as Roser and Ritchie (2015) state, the cereal yield/capita increased despite population growth but it still fails to satisfy all needs across the globe (due to its unequal distribution).

In terms of land use, there is a clear evolution starting with 1961 on the entire agricultural sector, which shows an increase of land use by 16% for cereal yield. The main threat to land use and land cover, nowadays, results from climate variability and change. These effects can lead to damage for ecosystems and many important goods and services they would provide to society (Entwisle and Stern, 2005). In Romania, the most affected area is the South-Muntenia Region, characterized by a temperate continental climate of Mediterranean transition. The temperature is, on an average, of 10 degrees Celsius and over 11 degrees Celsius in the Danube meadow; precipitation at 500-600 mm/year, about 78-80% air humidity and an annual averaged evapotranspiration potential of over 700 mm/year (Sandu et al., 2008; Dragotă et al., 2011). Given Romania's conditions and objectives to increase yields on cereals and other crops, it is also very important to identify the wheat varieties that are proper to pedo-climatic conditions for our country and especially for the South-Muntenia Development Region. The correlation of these traits leads to a process of selection of the optimal features, which determines the reproduction of the pedo-climate optimized varieties. At present, it is known that the classification of the Romanian grain varieties resembles the Canadian one, with which they have mixed and bred in order to improve the quality.

Various varieties that are found in our country, have different results manifested by the capitalization of local natural conditions at different intensities, but also according to the access to modern technologies and information, but also in the relations to the market. The quality/price ratio, very important for the moment, is determined on the basis of the assessment factors which mainly include the qualitative aspects of the wheat harvest obtained in 2014 in Romania.

Romania's accession to the European Union practically means the implementation of its requirements at all stages of food chain, from harvesting to consumption. Thus, to obtain the basic food, bread, wheat accumulates energy, protein, vitamins and minerals and consequently, it directly influences the quality of food, but most of the consumers do not know really understand that the physical and chemical properties of wheat (e.g. hectoliter mass, fall index, protein, wet gluten, gluten index, impurities, etc.) directly influence the quality of the bakery products that they purchase. For this reason, the paper presents theoretical aspects regarding the importance of cereals and the place of wheat in the economy. More-

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over, using several variables connected to quality and to economic performance we identify the most suitable areas for wheat culture at county level in Romania Thus, it is necessary to grow wheat in areas with favorable conditions, respecting the requirements of the species against the vegetation conditions, and the technology to "personalize" and, at the same time, respect the GAEC, in order to attain sustainability and to ensure growth of the sector by bringing superior products on the local, European and global market.

2. General framework and literature review

2.1. Soil quality

Geographical position (edaphic indicators and soil quality one) and cultivated species, as variables in a multi-criteria statistical analysis, can effectively explain yield and variability. It is the consequence of studies conducted in an East-Hungarian region by Juhos et al. (2016). Analyzing the main factors of production (soil: solonetz, chernozems - cultivated species: winter wheat, maize, sunflower – crop-rotation), the yield of the relatively better environment was found by cumulating the indicators. Consequently, the gradual linear regression process is a successful method of revealing the site-specific relationship, soil features and yields, and reviewing edaphic indicators and the Hungarian soil quality index at local level, as claimed in his research, Juhos et al. (2016).

Soil characteristics are determined by the factors of formation, namely climate, parental material, time, topography and biodiversity, and dynamic or user-dependent properties are influenced by management practices imposed by mankind. Both are important in terms of sustainability (Table 1). As a result, it is important to understand that the inherent and dynamic indicators of soil quality need to be observed over time and that their value is variable because soils are living systems.

Table 1. Hierarchy of agricultural indices showing soil quality as one of the critical foundations for assessing sustainable land management

Agricultural sustainability	**Environmental quality**	**Soil quality index**
Environmental quality	*soil quality index*	*physical indicators*
		chemical indicators
		biological indicators
	air quality index	
	water quality index	
Economic sustainability		
Social viability		

Source: Karlen et al., 2004

The assessment of soil properties is the prerequisite for interpreting how they create land use (e.g. crop yield, forestry, etc.). But, frequently, the dynamic assessment of soil quality has focused on a depth of 20-30 cm, and the description

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of a soil condition is the answer for a decision to manage land use within a short time (<10 years) (Karlen L.D. et al., 2004). Therefore, the traditional soil study, classification, interpretation and dynamic quality assessment are not competitive but complementary concepts. Under this context, the real soil quality calibration requires more than just comparing values on soils or management systems. Soil quality must be highlighted under landscape context, because most ecosystem functions depend on many connections during time and space (Karlen et al., 2004).

Andrews et al. (2002) were the first to compare multi-parametric methods to determine the quality of agricultural soils, focusing on methods of selecting indicators: from experts' opinion (Doran and Parkin, 1994) to different statistical mathematical systems. Based on these, a minimum of valid indicators for soil quality in plant production systems were selected.

Zalidis et al. have underlined since 2002 the need for information on the state of soil resources and the correlation of soil quality with sustainable management of agricultural practices.

It is found that 36% of the arable land have good and very good conditions for the field crops (the sum of the credit points exceeds the value of 61). The 3rd class, covering 38% from the total, offers enough conditions for the vegetal holdings (up between 41 and 60 points which express certain attributes of suitability).

The pedological research has already identified for a limited area in Romania such as the South-Muntenia Development Region, whose arable land predominates in the land fund structure the specific cereal traits of the four counties near the Danube. Thus, Figure 2 presents graphically the 7 soil types, predominantly the cernisoyls class (the chernozems are well known and their place of formation, symbolically "1.1"). The chernozem, (FAO, 2006) with a thick layer of black surface, rich in organic matter are the best alternative; most luvisols are fertile soils suitable for a wide range of agricultural uses; Cambisoyls are generally suitable for agriculture and are used intensively; the main obstacle to using gleysoyls is the need to install a drainage system to reduce groundwater mass; Región is of minimal agricultural importance.

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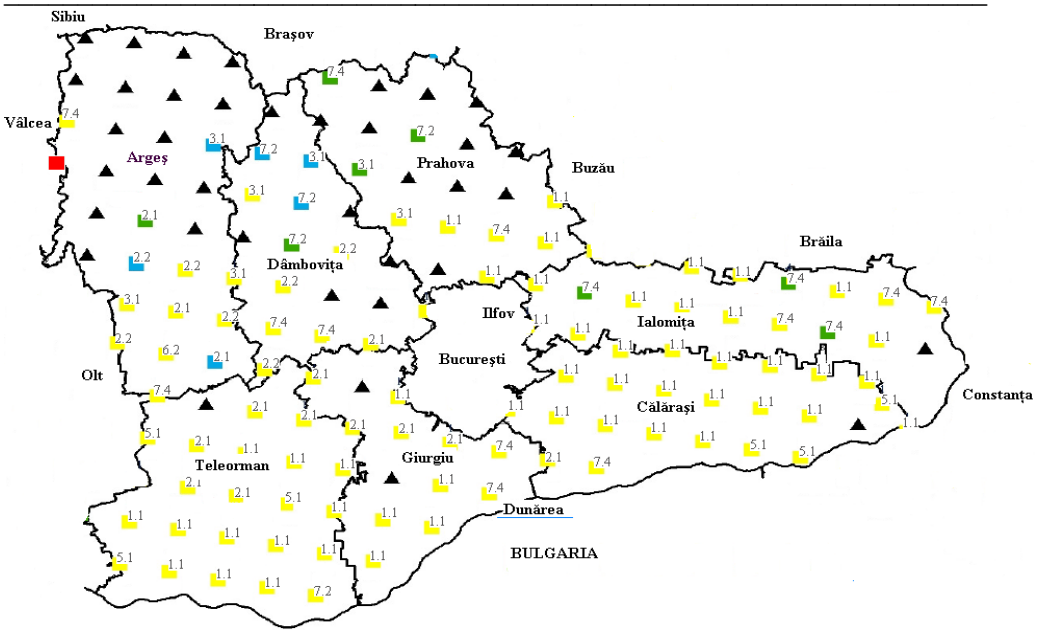

LEGEND		
Site forestry		▲
Meadows		
Arable		
Pastures		
Orchards		
Vineyards		
Class Cernisols	Chernozems	1.1
Class Luvisols	Brown argiloiluvisols	2.1
	Preluvisols reddish (red-brown)	2.2
Class Cambisols	Eutricambosols	3.1
Class Hidrisols	Gleysols	5.1
Class Protisols	Regosols	7.2
	Aluvio-soils	7.4

Source: I.C.P.A. Bucharest

Figure 1. The soil structure in the South Muntenia Development Region

In order to obtain the best performance from a soil, it is necessary and important to know and understand its properties and characteristics. Some soil properties, such as active soil profile, useful soil and texture may vary across farm and pedology profiles, but they have a high degree of stability over time. Other properties (eg stability of soil structural aggregates, reaction, settlement status, content in macronutrients, etc.), respectively those with a dynamic character,

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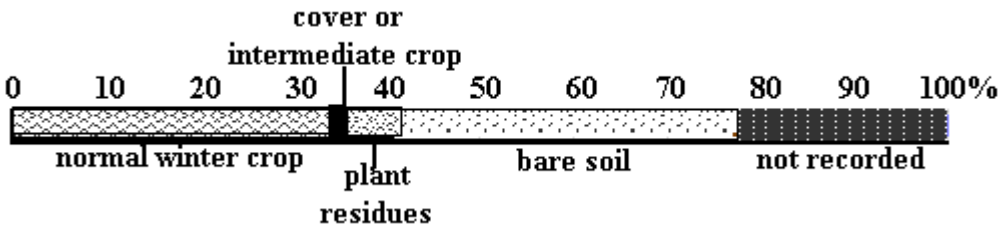
record significant changes through the application of soil cultivation technology systems (Good Practice Guide to combat soil degradation in the farm). As a result, Dr. Rudi Hessel, environmental scientist at Wageningen, stated that from the farmer's/researcher's point of view, the solutions need to bring benefits by increasing the profitability of the field work. The success is provided by locations subject to observations, under different pedo-climate and even extreme climatic zones (I.C.P.A., 2016).

The main threat to land use and land cover results from climate variability and climate change, and these effects can lead to a damaged ecosystems and low quality goods. Research in the field shows that there is a high probability to have areas, mostly in the southern and south-eastern regions of Europe, affected by drought, excessive heat, water scarcity. This will ultimately result in obtaining a declining crop yield and qualitatively inferior (Păltineanu et al., 2007, Păltineanu et al., 2009). Studies conducted for Romania reveal that the most exposed areas affected by aridity and desertification are the south-east and east of our country (Marica and Busuioc et al., 2004; Sandu et al., 2010, Dragotă et al., 2011).

2.2. Wheat, small grain of economic importance and protection of soil in the cold season

The analyses of the land use from 1961 to the present days, shows that there is an increase in term of land used for grain production, and also that there is an increase in the average yield. On the basis of this FAO study, the 2030 forecasts have also stated: arable crops increasing by 22%, respectively 57% under irrigation. With regard to wheat, it is also expected to increase the area by 75% and the yield by 73% (FAO, 2006). The predictions for wheat are also encouraged by the fact that wheat has a very high ecological plasticity and research is working continuously to improve the genetics of the species. At EU level, more than 30% of arable is occupied with winter wheat (Figure 3). This situation has a positive effect by opposing soil erosion and, implicitly, increasing its fertility. "In some Member States requirements to either have normal winter crops like winter wheat or cover crops as defined here on a certain percentage of the arable land are included in legislation or are part of the agri-environmental schemes farmers can adhere to".



Source: Eurostat statistics explained, 2010. Agri-environmental indicator - soil cover; http://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_soil_cover

Figure 2. Soil cover on arable land

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In Romania, the importance of small grains and, particularly, of wheat is suggested by the food tradition in bread consumption (Tables 2 and 3) and the many industrial products that can be obtained from grains and vegetable residues, but also from the role of the species in agroecosystems, including as a soil protector against winter erosion.

Table 2. Wheat nutritive value

Food value of wheat and its products	Recommended amount		Protein
	g/capita*day	g/capita* year	g/capita* year
- energetic matter (347 cal./100g wheat grains);	300-700 g bread (good nutrition)	182.500	13.687
- proteins/10 amino acids (7-8 g/100g bread; 9-12 g/100 g pasta, semolina, wheat flour; Rompan.ro); - Complex B vitamins (especially B1), PP; - 1.5 – 2.3 % minerals into wheat grain (P, K, Mg, Ca, Si, Na, Cu, Mb, Mn)	50-80 g other cereal derivates	23.725	0.249

Source: interpretation and original calculation, as average

Table 3. Chemical components of wheat grain

Grain part	carbohydrates, g	Proteins, g	Lipids, g	Fibers, g	Others
Pericarp	63	16	3	43	Complex B vitamins
Endosperm	79	7	0	4	
Embryo	52	23	10	14	Complex B vitamins; Omega 3/6 acids

Source: Muntean et al., 2003

The predominant component of the anatomical structure (Embryo 3%, Shell pericarp 6%, Spermoderma 4%, Aleurone Layer 8%, the endosperm 79%) is rich in proteins, of which gliadin and glutenin, in the presence of water, form gluten, with role in baking (dough quality). Without a quality raw product, we cannot talk about quality in bakery, and therefore it is important to specify that the shape and size of wheat influences the content of gluten; for example, one can notice gluten-rich in small and elongated grain varieties (biological properties).

Even though the conditions in Romania ensure pedo-climate favorability of the species *Triticum aestivum* (L.), for a sustainable food system at national level, primitive forms are still preserved in culture. They are used to obtain evolved forms represented by numerous varieties (releases of Romanian research

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coordinated by NARDI Fundulea). Import and export of wheat varieties grown in Romania are presented in Table 4.

Table 4. Varieties cultivated in 2013 and qualitatively analyzed in 2014, in Romania

No.	Wheat varieties (106 varieties)
A	Actual, Adelaide, Akteur, Alex, Alinia, Altigo, Andalu, Andino, Andrada, Aniversar, Antonius, Apache, Apullum, Aratos, Arezo, Arieşan, Arlequin, Arnold, Astardo, Athlon, Atigo, Atoco, Atrium, Azimut
B	Bekes, Bereş, Bitop, Boema 1
C	Capo, Carina, Chevalier, Ciprian, Crina, Crişana, Csardas, Csillag
D	Delabrad 2, Discus, Dor F, Dropia, Dumbrava
E	Elemeno, Elia, Enola, Exotic
F	Fabula, Faur, Felix, Flamura 85, Florian, Frit, Fulvio, Fundulea 4
G	Gasparom, Genesi, Genius, Glosa, Gold, Gruia
I	Ilinca, Izvor
J	Jindra, Joker, Josef
K	Kalango, Kerubino, Kiskum Gold, Kolo, Kristina, Kvadrili
L	Litera, Lovrin 34, Lucilla, Lupus
M	Marsall, Midas, Miranda, Mullan
N	Novi Sad, NS 40S
P	Panonia, Panonikus, Pedro, Pitbull, PG-102, Philip, Pobeda, Potenzial, Privilege
R	Renan, Renesansa, Rusjia, Roxanda
S	Serina, Simoniat, Simumida, Sirtaki, Sobbel, Soisson, Sorrial, Stefanus, Szemphalom
T	Taller, Toborzo
Z	Zimbru, Zora

Source: IBA Paper– Bucharest, no. 19, Quality of the grains from the harvest of 2014

As a result of application of the customized technology and under different local conditions, national average yields of 3.7 t/ha (2014) were obtained; the highest total outputs were obtained in the counties of Buzau and Timis. In the last year, 2016, the average yield was 3920 kg/ha (www.madr.ro), which can be mostly explained by the evolution of the weather.

To ensure the economic, dynamic and sustainable growth of a development region, it is necessary to achieve efficient capitalization of regional and local potential (fact that is also valid in the case of wheat yield). "Studying the regional development potential of Romania in various fields is one of the important concerns of the researchers."

The quality of wheat yield is influenced by cultural, natural (exploited) and artificial parameters (technology: input allocation, harvest time). Thus, after harvesting, the product samples are taken and immediately analyzed at the

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reception (hectoliter mass), then passed to a specialized laboratory for analyzes that precede industrialization (e.g., obtaining the flour and the dough). Table 5 summarizes the dimensions/characteristics on the basis of which the quality of wheat production is assessed.

Table 5. Quality indices of wheat grains

No.	Index	Specification and the best value
1	Hectoliter mass, kg	MH > 78kg → very good quality
2	Air humidity, %	Max. 14% → very good quality
3	Falling index, sec.	Hagberg index- information on both amylase activity (especially α-amylase) and fermentation process from dough
4	Protein, %	The amount of proteins in 100 mass units (100 g sample) related to dry matter; → very good quality
5	Wet gluten, %	The amount of proteins which is separated by washing with sodium chloride solution 2% of a dough obtained by flour, followed by its drying. Order no 250/531/83/2002 of the ministry of agriculture, food industry and forestry, of ministry of the health and family and of the State Secretary of ANPC, laying down methodology for production, content, packing, labeling and quality of wheat flour for human consumption. Wet gluten > 26% → very good quality; cdep.ro
6	Deformation index, mm	Difference between initial diameter of a 5 g wet gluten sphere and its diameter after 1 hour resting at 30°C. For a very good quality, the index ranged between 3 and 13 mm.
7	Gluten index	Functioning protein component, which determines many processing traits in wheat: as gluten content is higher, the dough volume increase more; very good gluten index has values ranging between 65 and 80

As a beneficiary of the bakery wheat product, Rompan, for example, analyzes quality indices according to SR ISO 7970/2001, but also uses many other standards, like: SR EN ISO 712: 2010, SR ISO 7971-2 / 2002, STAS 6283 / 1-1983, STAS 6283-4 / 1984, SR ISO 3093/1997 revised and completed by SR EN ISO 3093/2010.

Another indicator of major importance and which is determined in an organoleptic manner is the content of impurities in the mass of the wheat sample. Impurities are of several categories (e.g. grains presenting disease/pest attack, shrimp, grains, crop residues, weed seeds, etc.) and are determined according to SR EN 15587: 2009.

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3. Methodology – index of performing measurement

In order to analyze the performance of Romania, from a county perspective, to produce high quality wheat, a multi-criteria analysis was carried out. As far as the quantitative analysis is regarded we have used the principal component analysis and afterwards, based on the obtained principal components we have constructed four main clusters.

We have used nine indicators: 6 covering the main dimensions used in assessing the quality of the wheat production (for each dimension we have identified the number of species with excellent quality), and three covering economic dimensions: average price per unit (kg), cultivated area and average production per unit (hectare).

Table 6. Variables used in the PCA analysis

Variables	Min	Max	Average	Std. dev.	Source
Hectoliter mass	0	30	8.12	9.03	IBA Buc., 2014
Fall Index	0	31	8.37	7.62	IBA Buc., 2014
Protein	0	31	7.88	8.39	IBA Buc., 2014
Average gluten	0	33	8.71	8.98	IBA Buc., 2014
Gluten Index	0	40	5.49	7.29	IBA Buc., 2014
Impurities	0	12	2.46	3.12	IBA Buc., 2014
Price_2014	1	1	0.72	0.11	NIS
Area_2014	2.51	178.5	51.72	51.19	NIS
Average_prod_2014	0.25	17.85	5.17	5.12	NIS

Source: Authors' work

Table 7. The thresholds for each of the dimensions used for assessing the wheat quality

Hectoliter mass	Falling index	Protein	Wet gluten	Gluten Index	Impurities
>78 kg	220-280 sec.	>13%	>26%	65-80%	Max. 3%

For conducting the ACP, needed for reducing the dimensionality of our dataset we have followed the standard procedure using SPSS software. By reducing the dimensionality one transforms the space of initial variables (X – matrix) into a new space (W- matrix).

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$$\begin{bmatrix} x_1 \\ x_2 \\ \dots \\ x_n \end{bmatrix} \quad \Psi \mapsto \quad \begin{bmatrix} w_1 \\ w_2 \\ \dots \\ w_k \end{bmatrix}$$

Through the transformation process, each new principal component is a linear combination of the initial variables and is constructed so that each new component extracts the maximum variance possible from the remaining variance (after the extraction of all previous components).

$$w_i = a_1 * x_1 + a_2 * x_2 + \dots\dots + a_n * x_n$$

The variables of the new space (the w PCs) are orthogonal so that each recovers different parts of the initial variance of the X space. Due to practical reasons and also in order to facilitate the interpretation of the results one will include in the analysis only the first PCs (those with eigenvalues above 1).

After performing the ACP we will use the new PCs in order to construct some clusters which will facilitate the identification of the most suitable areas for wheat cultivation.

4. Results and discussion

The quality of wheat in Romania is unequal and is at some extent generated by the spreading area of the *Triticum* species from the plain to the hilly area, on soils of different classes of fertility, with different minerals due to percolation, but also due to extreme variations in temperature and rainfall. At the same time, when analyzing performance it is necessary to also refer to other wheat varieties that populate the field and are appreciated by the cultivators. By analyzing the bibliographic data, 4 native varieties and 2 foreign ones were found in several counties (Table 7).

Table 8. Varieties selected by farmers

Variety	Provenance	No of counties	Observations
Glosa	NARDI Fundulea	9	Highest level of the yielding ability (10400 kg/ha) registered in Braila County, in 2015
Apache	Foreign variety	6	
Arieșan	ARDS Turda	5	Yields of 5500 - 10500 kg/ha
Alex	ARDS Lovrin	3	Yielding ability 5297 kg/ha in the South of Romania too, in 2009
Flamura	NARDI Fundulea	2	Yielding ability: 4000 - 8200 kg/ha
Renan	Foreign variety	2	

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Choosing the wheat variety that ensures a good match between the natural resources of the area and its biological peculiarities is a prerequisite for obtaining large and stable production. At the same time, the varieties must have good resistance to the risk factors and several wheat varieties were designed, and genotypes and phenotypes were correlated (Akram et al., 2008). The correlation of these traits leads to a process of selection converging to the optimal required traits, which, in turn, determines the optimized pedo-climatic varieties. Among the many methods used globally, the analysis of correlation coefficients is the most widespread (Hristov et al., 2011). Licker et al. (2010); the crop yields achievable under different climatic areas around the world are compared with yield patterns of similar climates and Van Ittersum et al. (2013) who proposes further studies to analyze the global wheat yield gap, taking into account the weather and local agronomic components. These aspects were the basis for the new varieties brought to Romanian in the research resort coordinated by NARDI Fundulea.

In order to identify the areas with the highest performance in what the wheat cultivation is regarded we have performed the ACP on the nine standardized variables. Over 67% of the initial variance was recovered by the first two components which are also the only two with Eigenvalues over 1. By rotating the components the disequilibrium between the two components was slightly diminished, and therefore the second recovers almost a third from the total recovered variance.

Table 9. The retained principal components

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	**4.602**	**51.137**	**51.137**
2	**1.464**	**16.271**	**67.408**
	Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	**4.602**	**51.137**	**51.137**
2	**1.464**	**16.271**	**67.408**
	Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	**4.154**	**46.152**	**46.152**
2	**1.913**	**21.255**	**67.408**

Source: Authors' work

After performing the Varimax rotation the nine initial variables cluster under the two components as displayed by the following table, namely: the first five and the eight under PC1 and the remaining under PC2. As a consequence, the first component (PC1) which is positively correlated mainly with the variables

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representing the quality dimensions of the wheat production and also positively correlated with the cultivated area will represent the quality dimension (PC1 – quality of wheat). The second component correlates mainly with the impurities dimension, the average price/unit and the average production per unit and therefore might be regarded as an economic performance dimension – PC2. The negative correlation between the component and the price makes the interpretation of the component somehow difficult and presents the counties with large average production per unit and low price per unit (kg) as performant and the ones with low average production and high average prices/unit as being units with a lower performance.

Table 10. Rotated Component Matrix

	Component	
	1	2
Hectolitric_mass	**.626**	**.507**
Fall_index	**.886**	-.064
Protein	**.919**	.273
Wet_gluten	**.925**	.280
Gluten_Index	**.685**	-.213
Impur	.332	**.584**
Price_2014	.113	**-.730**
Area_2014	**.823**	.376
Avg_prod_2014	.082	**.662**

Source: Authors' work

By analyzing the component score coefficient matrix, one can observe very easily the importance of the initial variables in constructing the two PCs, namely: the quality PC and the economic performance PC.

Table 11. Component Score Coefficient Matrix

	Component	
	1 (quality)	2 (economic performance)
Hectolitric_mass	.095	**.210**
Fall_index	**.262**	-.184
Protein	**.217**	.018
Wet_gluten	**.217**	.022
Gluten_Index	**.229**	-.243
Impur	-.001	**.306**
Price_2014	.151	***-.469***
Area_2014	.172	.097
Avg_prod_2014	-.085	**.395**

Source: Authors' work

Using the two newly constructed PCs we plot the 41 territorial units, the Romanian counties and identify different clustering patterns. As expected, the

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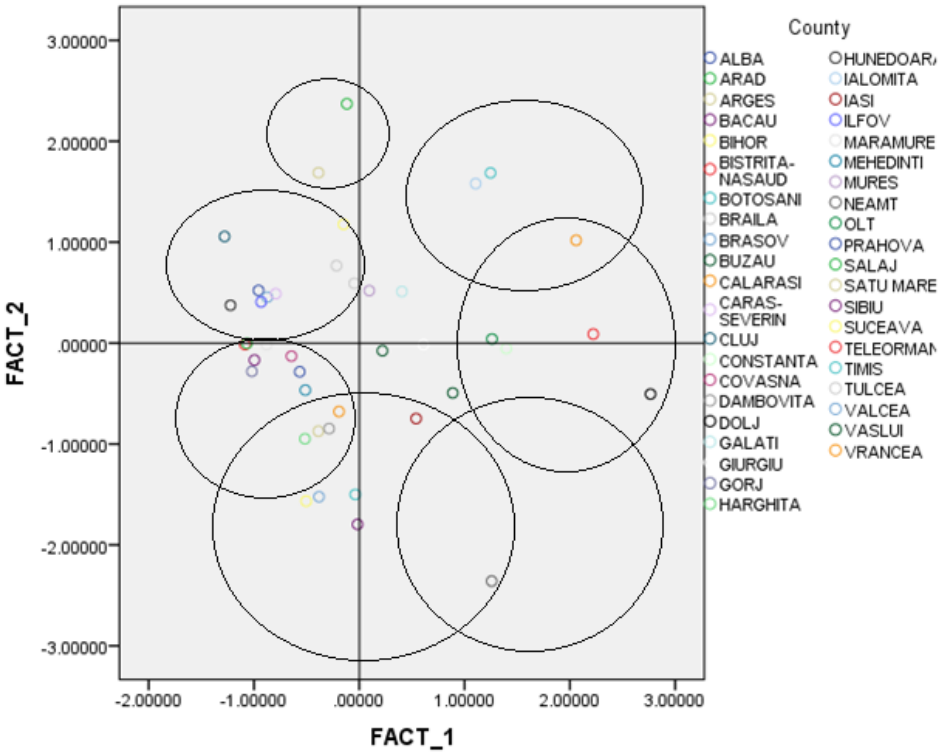
largest values for the first PC are recorded by Calarasi County, Dolj County and Teleorman County, all of them being localized in the southern part of the country (the Romanian Plain). On the other hand, for PC2, large values are displayed by the counties Arad County, Timis County, Satu-Mare County and Ialomita County (the first three are all clustered on the West Plain). Although, due to the construction of the component these counties are not homogenous as the price and the average production is regarded, but are similar in what the aggregated value of the PC is regarded.



Source: Authors' work

Figure 3. The distributions of counties in the two dimensional space of the two PCs

Going further with the clustering approach we have defined four clusters so that we can somehow identify for main types of counties in what the performance of wheat production is regarded with respect to these two main dimensions: quality of production and economic performance of production.

Table 12. Clusters based on the values for the two retained PCs

Cluster	PC 1	PC 2
Cluster 1	Positive Value	Positive Value
Cluster 2	Positive Value	Negative Value

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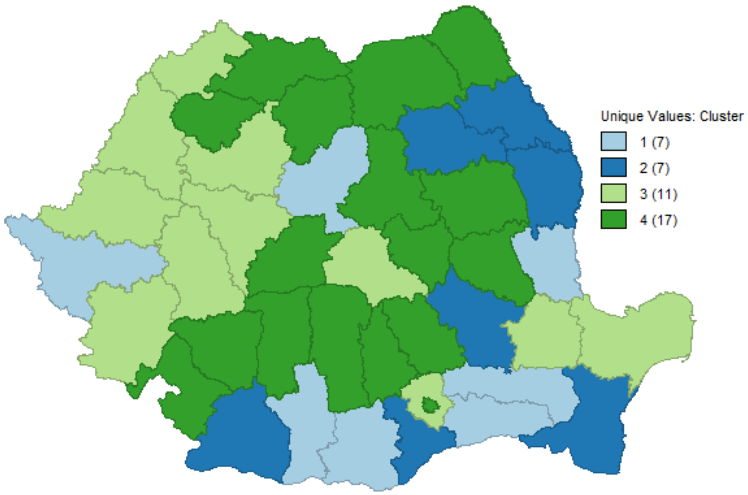
Cluster 3	Negative Value	Positive Value
Cluster 4	Negative Value	Negative Value

Source: Authors' work

The first cluster includes seven counties located mostly on the southern part of the country. The only surprising county, as long as the geograpghic perspective is regarded is the Mures County. Although, its clustering is no longer surprising after analyzing the individual variables related to quality which show that Mures County is one of the best preforming counties. The second cluster includes other seven counties with high quality but with lower economic performance. Within the third cluster we find eleven counties, mostly located in the western and north-western part of the country. These countyes have lower quality but positive economic performance. Finally, seventeen counties are included in the fourth group where both the quality of the product and the economic performnce are negative, in what the PCs are regarded.



Source: Authors' work

Figure 4. The clusters constructed based on the two retained PCs

Our results overlap with the pedogenic potential of the areas, as presented in "Material and Method", section 1. So, the chernozems are responsible for the superior quality of agricultural yield and the quality of wheat bread.

It needs to be emphasized that the result regarding the quality of the wheat product followed an inverse analysis: the quality of the product has identified the quality of the area, namely the agro-productive area, and therefore, the secret of the farmer's success lies in the soil. The soil is responsible for the accumulation and supply of nutrients and energy for living organisms, as well as for ensuring the other favorable conditions for the development of these organisms. Through this role, it is compared to a huge plant, which produces permanent, planetary, using automorfe, phytomatous processes, which are the basis for the development of

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heterotrophic organisms, including humans. Without the phytosomal assurance of nutrition with carbohydrates, proteins and other compounds, as well as the necessary energy, life on the globe would not exist (Florea, 2003).

5. Conclusions

Wheat is the main grain crop in Romania for bread production and the production includes many local and foreign varieties. Annually, sizable areas are sown in all counties of the country, in agricultural holdings of different types, according to technologies according to the entrepreneur's competence. The Romanian producers have recently faced market competition and have focused on increasing their knowledge in the field. The quality of wheat yield is influenced by cultural, natural (exploited) and artificial parameters (technology: input allocation, harvest time).

By using the principal components analysis we have proposed a methodology for assessing the performance of the Romanian counties in what the wheat production is required. Our approach has included both dimensions measuring the quality of the production and also dimensions measuring the economic performance of the process. The ACP has provided two main components, the first measuring the quality of the production and the second measuring the economic performance of the production. Clustering the Romanian counties into four groups using their scores on these two dimensions was one of the main results of the current research. As expected, the southern counties, namely: Dolj County, Olt County, Ialomita County and Calarasi County are among the counties with high performances on both dimensions. Likewise, the fourth cluster including the counties with low performances on both dimensions contains the counties with very little adequate land (for wheat cultivation), namely counties where mountains and high hills are covering most of the area.

Also noteworthy is the fact that by correlating the quality indices (first PC) with the economic performance of the cultivated areas (second PC) and also with the varieties cultivated at county level one is able to get a very coherent view of the Romanian sector.

Our research contributes to the development of the knowledge of the field and has also a high practical usability both at micro- and macro-levels. Thereby, the producers/farmers might be guided in choosing wheat varieties, optimizing their technology, and capitalizing on production. At macro level, the information provided leads to the correlation of wheat quality with the production environment in order to meet market (external) and food safety requirements. Our results might also prove useful for the policy makers so that they can develop strategies and invest in infrastructure for insuring the sustainability of the sector.

As further research we consider that replicating the approach for other sectors (crops) might prove very useful in constructing a general map of the agricultural performance and potential of the different counties so that the

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Romanian sector can not only supply the internal demand but can also become a notable player on the European and even global market.

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