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EVALUATION OF DIFFERENTIATION BETWEEN ROMANIAN WALNUT CULTIVARS AND THOSE WITH LATERAL BEARING FROM WARMER AREAS

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Abstract. *Walnut (Juglans regia L.) is a fruit tree crop grown in over 50 countries around the world with a total production of over 3,458,046 tons/year in 2013 (FAO State Database, 2016). The production is growing from year to year, however demand is higher than production globally. In recent decades, in the walnut culture, two kinds of cultivars are used: terminal fruit bearing cultivars from the temperate zone (Romania, Germany, England, Serbia, Czech Republic, Russia, Republic of Moldova, etc.); lateral fruit bearing cultivars originating in the warmer areas of Iran, Spain, USA (California), and more recently in countries such as France, Chile, Greece, Australia, etc. Terminal fruit bearing cultivars (including Romanian walnut cultivars) differ from those with lateral fruit bearing habit: better resistance to low temperatures (tolerate temperatures of -26ºC, -28ºC, those with lateral fruit bearing are affected at -20ºC, -22ºC); lower susceptibility to blight (caused by Xanthomonas campestris pv. juglandis); lower fruit yields (2.0-3.0 t/ha for terminal bearers and from 3.2 to 3.8 t/ha for lateral bearers); less expensive cultivation technology.*

Keywords: nut crops, walnut, *Juglans regia*, cultivars, growing.

1. Introduction

The walnut (*Juglans regia* L.), named Carpathian, English or Persian, is grown in more than 50 countries worldwide in both hemispheres.

The global walnut culture is booming because of its economic benefits and high demands on the market.

The request for walnut kernels is much higher than the current world production.

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World walnut production was in 2014 over 3,462,731 tons and the area harvested was of 994,738 ha (FAO Stat Database, 2016). Romania is in the top 10 countries in the world with a production of 30,000 – 35,000 tons/year. Romania ranks in the second place in the E.U. after France. In 2014 the domestic production reached 31,275 tons of in-shell walnuts.

The food value of walnuts, complex content in useful compounds for the human health status, high energy value, the special value of the wood for the furniture industry, maintenance of the environmental balance and the alelopathic effect of walnut orchards, etc., (Jenkins ș i Ebeling, 1985; Duke, 1985; Botu et al., 2013), made this crop very important (Jenkins and Ebeling, 1985; Duke, 1983; Botu et al., 2014).

Botu and Botu (2000) state that the primary genetic diversity region for walnut is Central Asia. The natural distribution of walnut is restricted to central Asia, where it is threatened by fruit collection, livestock grazing and cutting (IUCN Red List, 2007). From this part of the world (Persia) walnut came to Rome from Greece and then the Romans spread walnut in Southern Europe to England (Goodell, 1984). An important secondary genetic diversity centre for walnut seems to be located in the Balkans, including Romania (Botu et al., 1994).

2,000 years ago, the Latin poet Ovid (43 B.C. - 17 A.D.), exiled in Tomis (nowadays, the city of Constanţa, on the shores of the Black Sea) mentioned the existence of walnut trees in Dobrogea Region (Ghena, 1964). The genetic diversity of the *Juglans* genus is very high because it includes a large number of species. Among these, *Juglans regia* L. holds an utmost importance for the walnut production, the surface of the cultivated area and distribution.

Due to the increased polymorphism regarding the trees and fruiting characteristics two distinct types of cultivars are grown in different countries:

- terminal bearing walnut cultivars;
- lateral bearing walnut cultivars.

Genetic and geographical origin of walnut cultivars

A germplasm walnut collection has been established at Vâlcea Fruit Growing Research & Extension Station (SCDP Vâlcea). Since 2010 the research station belongs to the University of Craiova. The germplasm collection is part of the national collection (field gene bank) and comprises 118 walnut accessions. The accessions are formed of domestic and foreign cultivars (30), autochthonous biotypes, selections, hybrids, etc. 5 accessions are different *Juglans* species, the rest of 113 accessions belong to *Juglans regia* L.

Juglans regia is a diploid species (2n = 32). Genetic analysis using RAPD markers, ISSR and microsatellites known as simple sequence repeats (SSRs) have highlighted the genetic variability of the walnut provenances studied (5 to19 alleles per locus) and a high heterozygosity (0.597 to 0.644) (Fornari et al., 1999, Malvolti et al., 2001; Pollegioni et al., 2005, Pop et al., 2013; Pollegioni et al., 2005).

In the walnut collection located at SCDP Vâlcea cultivars, biotypes and natural hybrids of various origins are present. The genotypes formed into the conditions of temperate climate have terminal fruit bearing. Cultivars and selections from California (S.U.A.), SW France and the Caucasus, which have lateral bearing, are provenances with origins in warmer climates (Central Asia, Iran, Afghanistan, etc). Although the accessions with lateral bearing belong to *Juglans regia* L., their genetic and phenotypic characteristics are different if compared to terminal bearing cultivars.

2. Materials and Methods

The biological material used for this study consists of 18 walnut cultivars with terminal bearing (Table 1) and 9 with lateral bearing (Table 2) from the SCDP Vâlcea germplasm collection.

The cultivars have been grafted on *Juglans regia* seedlings. The planting was done in a trial belonging to SCDP Vâlcea, at 9.0 by 8.0 meters (density of 139 trees/ha) on an alluvial soil with slightly acid reaction. No irrigation was provided to the trees. The mean annual rainfall reaches 715 mm. The age of the trees is of 20 to 22 years.

Pruning was carried out annually for the walnut trees. The soil between rows was tilled annually.

Table 1. List of studied walnut cultivars with terminal bearing

No.	*Cultivar name*	*Geographical origin*	*No.*	*Cultivar name*	*Geographical origin*
1	‘Adams 10’	Oregon (U.S.A.)	10	‘Sarmis’	Hunedoara (Romania)
2	‘Argeşan’	Argeş (Romania)	11	‘Sibişel 44’	Hunedoara (Romania)
3	‘Franquette’	Isère (France)	12	‘Valcor’	Vâlcea (Romania)
4	‘Geoagiu 65’	Hunedoara (Romania)	13	‘Valcris’	Vâlcea (Romania)
5	‘Germisara’	Hunedoara (Romania)	14	‘Valmit’	Vâlcea (Romania)
6	‘Idaho’	Idaho (U.S.A.)	15	‘Valrex’	Vâlcea (Romania)
7	‘Jupâneşti’	Argeş (Romania)	16	‘Valstar’	Vâlcea (Romania)
8	‘Muscelean’	Argeş (Romania)	17	‘Velniţa’	Iaşi (Romania)

9	‘Orăştie’	Hunedoara (Romania)	18	‘Unival’	Vâlcea (Romania)

Table 2. List of studied walnut cultivars with lateral bearing

No.	*Cultivar name*	*Genetic origin*	*Geographical origin*
1	‘Ferjean’	‘Grosvert‘ x ‘Lara‘	Bordeaux (France)
2	‘Fernette’	‘Franquette‘ x ‘Lara‘	Bordeaux (France)
3	‘Fernor’	‘Franquette‘ x ‘Lara‘	Bordeaux (France)
4	‘Hartley’	‘Franquette‘ x ‘Mayette‘ ?	California (U.S.A.)
5	‘Lara’	Seedling of ‘Payne’	Gironde (France)
6	‘Payne’	Seedling selection	California (U.S.A.)
7	‘Pedro’	‘Conway Mayette‘ x ‘Payne’	California (U.S.A.)
8	‘Serr’	‘Payne’ x PI 159568	California (U.S.A.)
9	‘Vina’	‘Franquette‘ x ‘Payne‘	California (U.S.A.)

Sprays against pests and diseases were also carried out (6 ÷ 7 per year) depending on the alerts issued by Vâlcea Phytosanitary Office. Observations were done regarding the growth elements, yielding and adaptation to the specific ecological condition of the Vâlcea area.

3. Results and Discussions

The researches conducted over two decades at SCDP Vâlcea, into the Subcarpathian area of Oltenia, on walnut cultivars with various geographical origins and different agro-biological characteristics have highlighted their growth and yielding under the ecological conditions of this area.

The walnut cultivars with terminal fruit bearing habits (15 from Romania, 2 from U.S.A. and one from France) showed very different behaviours in comparison with those with lateral bearing (4 from France and 5 from U.S.A.).

The growth of the terminal bearing walnut cultivars proved to be higher than the lateral bearing ones, although the same type of rootstocks have been used for both types of cultivars.

The trunk cross sectional area (TCSA) taken into account was 1,151 cm^2 on the average in the 22nd year after having been planted in the orchard. In case of lateral bearers, mean TCSA reached 991 cm^2 in the same year (Table 3). The growth difference of TCSA between the two types of walnut cultivars was of 160 cm^2 those with terminal bearing being on the average by 16.1% more vigorous. The crown volume (CV) of the trees was of 235 m^3 on the average in the case of terminal bearers, while lateral bearers reached 183 m^3. The difference between the two groups of walnut cultivars was of 37 m^3, which represents 28.4% more for the terminal ones. Taking into account both TCSA and CV levels as indicators of growth vigour, the walnut cultivars having terminal bearing habit proved 20 to 30% more vigorous than the lateral ones.

Table 3. Growth differences between terminal and lateral bearing walnut cultivars depending on age

No.	*Specification*	*Age of trees* (years)	*TCSA* *(cm^2)*	*Trunk diameter* (cm)	*Crown volume* (m^3)	*The average length of annual growth* (cm)
1	Cultivars with terminal bearing (mean for 18 cultivars)	15	679	29.4	151	36
		22	1151	38.3	235	30
		Difference	*472*	*8.8*	*84*	*-6*
2	Cultivars with lateral bearing (mean for 9 cultivars)	15	579	27.1	136	64
		22	991	35.5	183	59
		Difference	*412*	*8.4*	*47*	*-5*
	Difference between cultivars groups	-	*160*	*2.8*	*37*	*29*

The lateral bearing walnut cultivars show a tendency to have, on average, stronger annual growth (64 to 59 cm) than the terminal ones (36 to 30 cm) in the 15th and 22nd leaf.

The difference of 29 cm (96.6%) for lateral bearing cultivars is due to the genotype and phenotype both giving the character of bearing fruits. When there is not enough long annual growth, the ability of these cultivars to produce fruits on lateral branches decreases. Taking into account the growth vigour of the studied walnut cultivars the suitable density in the orchard should be between 100 to 150 trees/ha, depending on the cultivar and 150 to 200 trees per hectare for lateral bearers.

Table 4. Advantages and disadvantages of cultivation of different walnut cultivars in the Subcarpathian area of Oltenia

No.	*Specification*	*Cultivars with terminal bearing*	*Cultivars with lateral bearing*
1	Growth vigour	High	20-30% lower
2	Tree density per hectare (*J. regia* seedling rootstock)	100 - 150	150 - 200
3	Flowering time (limits)	April 15-May 17	April 16-May 15
4	Precocity in bearing fruits (age)	4 - 6	3 - 4
5	Yield (kg/ha)	2010 - 2950	3260 - 3730
6	Fruit quality (shape, size, core yield, etc.)	Good	Good
7	Resistance to low temperatures	Good (-20°C; -28°C)	Weak (-18°C; -22°C)
8	Resistance to blight	Relatively good	Weak

	(*Xanthomonas campestris* pv. *juglandis*)		
9	Dependence on climate factors	Medium	Very high
10	Dependence on culture technology	Medium - high	Very high

The blooming time for the male and female flowers of the studied walnut cultivars ranged from the 15th of April till May 17. Out of the 27 cultivars the latest regarding blooming of female flowers proved ‘Fernette’ and ‘Fernor’ (lateral bearing cv.) and ‘Franquette’ (terminal bearer).

Coming into bearing fruits time takes place earlier for the lateral bearing cultivars, these cultivars being more precocious by 1 to 3 years (on average) than the terminal ones, although the fruit yields in the first productive years do not overpass 200-500 kg of dry fruits/ha.

Table 5. Fruit yields of terminal bearing walnut cultivars grown at SCDP Vâlcea

No.	*Cultivar*	*Cumulative yield (6^{th} to 22^{nd} leaf)* (t/ha)	*Average production (17 years)* (t/ha)
1	‘Argeşan’	41.31	2.43
2	‘Geoagiu 65’	41.65	2.45
3	‘Germisara’	38.42	2.26
4	‘Muscelean’	43.35	2.55
5	‘Orăştie’	41.14	2.42
6	‘Sarmis’	38.76	2.28
7	‘Sibişel 44’	34.17	2.01
8	‘Jupâneşti’	50.15	2.95
9	‘Valcor’	42.28	2.84
10	‘Valmit’	45.05	2.65
11	‘Valrex’	45.37	2.67
12	‘Velniţa’	44.54	2.62
13	‘Valcris’	45.56	2.68
14	‘Valstar’	43.18	2.54
15	‘Unival’	44.37	2.61
16	‘Franquette’	47.60	2.80
17	‘Idaho’	35.70	2.10
18	‘Adams 10’	36.55	2.15
Mean		***42.18***	

The lateral bearing walnut cultivars are generally known to be more productive per hectare than the terminal bearing ones. This can be explained not only due to larger yields per tree but also as a result of higher tree density per hectare in the case of lateral bearers and counting their precocity in producing yields.

In the given study condition from the trial located in Rm. Vâlcea which has no irrigation, the average yield of terminal cultivars was 2.50 t/ha (Table 5), while the average yield of lateral bearing cultivars reached 3.48 t/ha on average (Table 6). The terminal bearing cultivars' mean yields over 17 years of production oscillated from 2.01 t/ha ('Sibişel 44') to 2.95 t/ha ('Jupâneşti'). In the case of lateral bearing cultivars the yields were between 3.26 t/ha ('Fernor') to 3.73 t/ha ('Vina').

Table 6. Fruit yields of lateral bearing cultivars grown at SCDP Vâlcea

No.	*Cultivar*	*Cumulative yield* *(6th to 22nd leaf)* (t/ha)	*Average yield* *(17 years mean)* (t/ha)
1	'Fernette'	58.65	3.45
2	'Fernor'	55.42	3.26
3	'Ferjean'	61.51	3.62
4	'Hartley'	63.41	3.69
5	'Lara'	55.42	3.26
6	'Pedro'	59.33	3.49
7	'Payne'	61.03	3.59
8	'Vina'	62.73	3.73
9	'Serr'	55.59	3.27
Mean		***59.23***	***3.48***

The quality of the fruits for the two groups of cultivars (shape and size of walnuts, kernel efficiency and quality, exocarp thickness, etc.) is, on average, very similar.

One of the problems of cultivation of lateral bearing walnut cultivars in continental climate areas is their susceptibility to low temperatures during winter. Also, terminal bearers from warmer climates like 'Franquette' might be also susceptible to winter temperatures in colder growing areas.

Research carried out by Aslamarz et al. (2010) showed that one year old twigs (annual growth) of lateral bearing walnut cultivars can be affected in November at -7.5°C ('Serr'), -8.3°C ('Hartley'), -10.0°C ('Lara') and -11.6°C ('Pedro') and in December at -14.1°C ('Serr'), -10.8°C ('Hartley'), -19.1°C ('Lara') and -20.0°C ('Pedro'). Charrier et al. (2013) mention that buds of 'Franquette' and 'Lara' walnut cultivars resist during winter to -18.5°C.

Aletà et al. (2014) report over one year observation on frost hardiness of several cultivars including 'Franquette' (-20.9°C), 'Serr'(-20.5°C), 'Fernor'(-21.3°C) and 'Chandler' (-24.5°C). Almost the same behaviour of these walnut cultivars on frost hardiness might be explained by their closely related origin (Germain et al., 1999; cited by Aletà et al., 2014).

Gandev (2013) speak about the effect of extreme low temperatures (6 days with temperatures ranging from -13.0°C to -24.4°C) recorded in Plovdiv - Bulgaria on February 2012 on reproductive organs of lateral bearing cultivars 'Lara', 'Izvor 10' and 'Fernor'. 'Lara' proved to be most affected by low temperatures (98% of male buds and 90% of the females ones), followed by 'Fernor' (84.7%, respectively 32%) and 'Izvor 10' (40.7% and 23.3%).

Table 6. Minimum temperatures and recording times in 50 years. (Source: ANM Bucharest http://www.meteoromania.ro)

No.	Different areas from Romania	Lowest temperature in the last 50 years (°C)	Year of recording the absolute minimum temperature	Number of years with temperatures below -20°C	Ratio between number of years (50) and temperatures below -20°C	Number of years with temperatures between -26°C to -30°C	Ratio between number of years (50) and temperatures between -26°C to -30°C	Minimum annual mean temperatures over 50 years period (°C)
1	Bacău	-30.8	1963	26	1.9	2	25.0	-20.5
2	Brăila	-25.5	1985	5	7.4	-	-	-16.3
3	Galaţi	-23.4	1963	6	8.3	-	-	-16.2
4	Constanţa	-17.8	2010	-	-	-	-	-12.3
5	Craiova	-29.4	1963	6	8.3	1	50.0	-16.6
6	Iaşi	-30.6	1963	23	2.7	4	12.5	-19.8
7	Mangalia	-19.5	2010	-	-	-	-	-12.6
8	Oradea	-22.8	1964	10	5.0	-	-	-16.7
9	Piteşti	-23.8	1963	5	7.4	-	-	-15.7
10	Ploieşti	-29.5	1963	23	2.2	5	10.0	-19.9
11	Rm. Vâlcea	-27.0	1967	2	25.0	-	-	-13.6
12	Satu Mare	-30.4	1961	27	1.8	6	8.3	-20.7
13	Timişoara	-35.3	1963	11	4.5	1	50.0	-16.4
14	Tg. Mureş	-32.8	1963	28	1.8	5	10.0	-20.8
15	Braşov	-32.3	1985	43	1.1	17	2.9	-24.1

Over the last 20 years, in Romania, in locations like Constanţa and Mangalia minimum temperature below -20°C were not recorded, while in Rm. Vâlcea such temperatures occurred twice in 50 years (Table 6). Extreme low temperatures were recorded in 1985 in Brăila (-25.5°C) and Braşov (-32.3°C).

In Braşov, Tg. Mureş, Satu Mare, Bacău, Iaşi, Ploieşti temperatures below -20°C occur once every 3-4 years. Below -26°C temperatures during winter can be recorded in Braşov, Satu Mare, Ploieşti, Tg. Mureş, etc. In such areas, lateral bearing cultivars can be affected more than the terminal bearing cultivars. Lateral bearers have longer vegetation period (till mid November) and, in some years, when winter comes earlier, the trees suffer badly because they are not prepared for low temperatures. In such conditions, young trees (1^{st} to 4^{th} leaf) can be totally compromised. The behaviour of walnut cultivars to early and late frosts and to low temperatures during winter should be taken into serious account when establishing new orchards.

Carpathian walnut cultivars, which are terminal bearing ones, prove to be less susceptible to such events compared to lateral bearing cultivars, which come from warmer areas of the world.

During the studied period, lateral bearing cultivars proved more susceptible to blight (caused by *Xanthomonas campestris* pv. *juglandis*) on fruits and shoots. Contrariwise, these cultivars were less susceptible to anthracnose (caused by *Gnomonia leptostyla* fungus) than the terminal bearers.

Investment in large walnut orchards should be carefully planned taking into account long term analysis of the local ecological conditions and choosing appropriate cultivars and orchard management.

Conclusions

(1) Domestic walnut cultivars and some foreign ones with terminal bearing habits are adapted to the specific ecological conditions from favourable walnut growing areas of Romania.

(2) Lateral bearing walnut cultivars from U.S.A. and France are susceptible to temperatures below -20°C; -23°C during winter and for that reason establishing orchards with such cultivars should be done only in favourable ecological areas.

(3) In adequate ecological conditions and with proper management the lateral bearing walnut cultivars can be more productive than the terminal bearing ones.

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LONGEVITY OF RESEEDED GRASS SPECIES USED FOR RESTORING THE DEGRADED SUBALPINE MEADOWS

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Abstract. *In the summer of 1996, a degraded grassland, invaded by Nardus stricta species, located at 1,800 m altitude from subalpine level of Bucegi Mountains, after total herbicide with glyphosate, liming using CaO at* 2/3 Ah *(in autumn 1995) and paddocking with sheep* (5 nights, 1 sheep/m^2) *has been over-seeded or reseeded. The grass seed mixture was composed of Phleum pratense 40%; Festuca* pratensis 25%; *Lolium perenne* 5%, *Lotus corniculatus* 15% *and Trifolium hybridum* 15%*. A part of the variants have been fertilized with chemical fertilizers with doses of* N 150 K P50 50 kg/ha *and other plots have been fertilized with organic fertilizer by paddocking system applied before the reseeded grassland establishment. In 2004 and 2011 an organic fertilizing by cattle paddocking, has been practiced. In addition to the dry matter production has followed the evolution in time of wild grasses sown. The reseeded species that do not reach the maturity remain a much longer period of time than is known in the technical literature, this being of* 2-3 *times greater in the high mountains than in the lowlands and hills. In the grassy carpet the Phleum pratense species survives in large proportion, even after* 20 years *of sowing.*

Keywords: degraded grassland, herbicide, fertilizer, over-seeding, reseeding.

Introduction

Mountain pastures, used by grazing for many years, are exposed to processes of degradation of floristic composition, if not properly maintained, fertilized and used rationally (Barbulescu, Motca, 1983).

By applying organic (paddocking system) and chemical fertilizers, degraded mountain grasslands, invaded by strict *Nardus stricta* species, can turn into valuable pastures, dominated by *Festuca rubra* and *Agrostis capillaris* (Pușcaru et al., 1956). One of the most effective ways to improve *Nardus stricta* degraded grasslands is by total sward destruction (herbicides, harrowing, milling, plowing, etc.), followed by the establishment of reseeded pastures with high quality and production (Marușca, 1977).

Such research work to improve more effectively the *Nardus stricta* grasslands has been conducted in sub-alpine altitudinal level in the last 20 years (Marușca et al., 2015).

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One such long-term research activity at the sub-alpine level intended to determine the survival duration of some species of perennial sown grasses that it is different from the conditions at lower altitudinal levels, a topic presented in this paper.

Material and Method

At the Research Mountain Grasslands Base from the Bucegi Massive, located at 1,800 m altitude on a degraded pasture, with participation of *Nardus stricta* species over 60%, in the autumn of 1996, the grassy carpet was sprayed with 5 litres/ha Roundup product (glyphosate).

After two weeks were applied 7.5 tons per ha of lime (CaO) to correct 2/3 Ah of soil acidity (hydrolytic acidity**).**

On June 1996, after sheep climbing the mountain, it paddocked a sheep 5 nights/1 m^2, after which the land was harrowing at 2-3 cm deep and sown with a mixture of: *Phleum pratense* 40% *Festuca pratensis* 25% *Lolium perenne* 5%, *Lotus corniculatus* 15% and *Trifolium hybridum* 15%, all missing species of wild flora.

In the organically fertilized variant, paddocking was repeated, in the same rate, with sheep in 2004, and with cows in 2012.

Similarly, for comparison, the same mixture of grasses with chemical fertilizers N 150 P 50 K 50 kg/ha, during 1996-1998, 2004-2006 and 2012-2014 was fertilized.

After sampling for dry matter (DM) and chemical analysis, the pasture was used by grazing with cows. The sown species were not able to multiply by self-seeding, because they had not reached maturity. Annually, between 1997-2016, flora observations using the KLAPP-ELEMBERG method of participation percentage in phytomass, were made.

Results and Discussion

Following the floristic observations, over 20 years, every two years, it was possible to provide an overview of the dynamics of the sown and spontaneous species in the chemically fertilized variant (Table 1).

From this data it results that the best representation of sown species of 86% was in 1999-2000 and the lowest of 21% in 2011-2012.

The basic *Phleum pratense* species was maintained at a rate of 21-66% in grassy carpet, being the only species that has resisted for 20 years.

The remaining species have disappeared at different times, namely: *Festuca pratensis* after12 years, *Lolium perenne* after 4 years, *Trifolium hybridum* after 10 years and *Lotus corniculatus* after 8 years.

In the grassy carpet appeared the *Poa pratensis* species, from spontaneous flora, only 15 years after the start of the improvement work and *Taraxacum officinale* after 7 years. The pastoral value of reseeded pastures, chemically fertilized, is 61-83 and it is good to very good.

On the variant organically fertilized by the paddocking system, the success of sown species is greater than the chemical fertilization, being of 90% in the period 1997-1998 and 22% in 2015-2016 (Table 2). During the 20 years of observations, the only species that survived in this case was the *Phleum pratense* species, in a variable proportion of 22-55%.

In this case *Festuca pratensis* disappeared after 16 years, *Lolium perenne* after 6 years and the *Trifolium hybridum* species after 10 years, a little more enduring than the chemically fertilized variant.

Instead, in the paddocked variant, in the first year, from spontaneous flora, the *Taraxacum officinale* was established and after the 7^{th} year *Poa pratensis* maintained around 5%.

Pastoral value of organic variant has indices between 74 and 90, being superior to chemical alternative.

A comparison of the influence of the type of chemical to organic fertilizer is presented in Table 3.

These data show that organic fertilization has favoured the sown species *Phleum pratense*, *Festuca pratensis* and *Trifolium hybridum* and spontaneous species *Trifolium repens* and *Poa pratensis*.

The viability of the sown species, fertilized organically is longer than the chemical variant, with 2 years for *Lolium perenne* and with 4 years for *Festuca pratensis.*

Similarly, in the organic variant, the *Poa pratensis* species appears faster with 8 years and *Taraxacum officinale* with 6 years compared to the chemical solution. In general, the index of the forage value of organic variant is 9 times higher than the chemical variant.

Conclusions

❖ In the sub-alpine high mountains there are few species of perennial grasses and forage legumes adapted to these soil and climate conditions less favourable to plant growth;

❖ By providing optimal conditions of soil and fertilizer, timothy (*Phleum pratense*) manages to survive more than 20 years in a rate of 37% in the chemically fertilized variant and 33% in organic fertilization (paddocking) compared to 40% at sowing;

❖ The longevity of perennial sown grasses and legumes at high mountain altitude is at least two times higher than in the case of those sown at lower altitude in the plains;

❖ Paddocking by animals has favoured the sown species *Festuca pratensis* and *Trifolium hybridum* compared to chemical fertilization that has favoured the *Phleum pratense* species;

❖ From spontaneous flora *Poa pratensis*, *Trifolium repens* and *Taraxacum officinale* are stimulated by paddocking and *Festuca nigrescens* by chemical fertilization.

Table 1. The evolution of the floristic composition of sown pastures, fertilized chemically, Blana- Bucegi Mountains 1997 – 2016, (% Participation in aboveground phytomass)

Specii	1997-1998	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016
SOWN SPECIES	**64**	**86**	**53**	**57**	**55**	**37**	**29**	**21**	**34**	**24**
Perennial grasses										
Phleum pratense	30	66	41	45	49	33	29	21	34	24
Festuca pratensis	12	4	2	2	4	4	.	.	.	.
Lolium perenne	9	+	.	.	.	.	.	.	.	.
Perennial forage legumes										
Trifolium hybridum	12	16	10	10	2	.	.	.	.	.
Lotus corniculatus	1	+	+	+	.	.	.	.	.	.
SPONTANEOUS SPECIES	**36**	**14**	**47**	**43**	**45**	**63**	**71**	**79**	**66**	**76**
Perennial grasses										
Agrostis capillaris	8	4	15	14	17	33	34	27	20	23
Festuca nigrescens	7	1	12	8	5	6	8	11	14	9
Poa pratensis	.	.	.	.	.	.	.	1	3	4
Alte graminee	16	3	7	10	9	11	15	21	13	21
Perennial forage legumes										
Trifolium repens	4	4	10	6	7	10	11	10	7	10
Others families										
Ligusticum mutelina	+	1	+	+	1	2	2	5	3	4
Potentilla ternata	1	+	+	1	1	1	1	2	5	2
Taraxacum officinale	.	.	.	+	2	+	+	1	+	+
Alte specii	+	1	3	4	3	+	+	1	1	3
PASTORAL VALUE	**77**	**83**	**77**	**76**	**78**	**73**	**68**	**61**	**67**	**62**

Table 2. The evolution of the floristic composition of sown pastures, organic fertilized by paddocking, Blana- Bucegi Mountains, 1997 – 2016 (% Participation in aboveground phytomass)

Species	1997-1998	1999-2000	2001-2002	2003-2004	2005-2006	2007-2008	2009-2010	2011-2012	2013-2014	2015-2016
SOWN SPECIES	**90**	**76**	**52**	**56**	**67**	**53**	**29**	**24**	**24**	**22**
Perennial grasses										
Phleum pratense	22	33	35	45	55	42	25	23	24	22
Festuca pratensis	20	7	3	6	10	11	4	1	.	.
Lolium perenne	9	1	+	.	.	.	.	.	.	.
Perennial forage legumes										
Trifolium hybridum	38	35	14	5	2	.	.	.	.	.
Lotus corniculatus	1	+	+	.	.	.	.	.	.	.
SPONTANEOUS SPECIES	**10**	**24**	**48**	**44**	**33**	**47**	**71**	**76**	**76**	**78**
Perennial grasses										
Agrostis capillaris	1	8	12	13	17	28	34	32	20	25
Festuca nigrescens	1	1	1	5	1	+	1	1	2	5
Poa pratensis	.	.	.	2	3	4	5	4	5	5
Other grasses	2	1	14	8	2	1	5	8	5	8
Perennial forage legumes										
Trifolium repens	6	13	14	12	8	8	16	22	30	24
Others families										
Taraxacum officinale	+	+	1	2	1	2	5	4	7	5
Ligusticum mutelina	+	1	2	1	1	2	3	3	3	3
Potentilla ternata	+	+	1	1	+	1	1	1	2	1
Others species	+	+	3	+	+	1	1	1	2	1
PASTORAL VALUE	**90**	**88**	**76**	**82**	**89**	**84**	**76**	**75**	**79**	**74**

Table 3. Comparative data on the effect of fertilizer on species type and their longevity
in the grassy carpet Blana - Bucegi 1997 - 2016

Specii	Semănat 1996	Media 1997 - 2016			Durată specie (ani)		
		Chimic	Organic	Dif. + -	Chimic	Organic	Dif. + -
SOWN SPECIES	**100**	**46,0**	**49,3**	**+ 3,3**	.	.	.
Perennial grasses							
Phleum pratense	40	37,2	32,6	- 4,6	20	20	0
Festuca pratensis	25	2,8	6,2	+ 3,4	12	16	+ 4
Lolium perenne	5	0,9	1,0	+ 0,1	4	6	+ 2
Perennial forage legumes							
Trifolium hybridum	15	5,0	9,4	+ 4,4	10	10	0
Lotus corniculatus	15	0,1	0,1	0	8	6	- 2
SPONTANEOUS SPECIES	**0**	**54,0**	**50,7**	**- 3,3**	.	.	.
Perennial grasses							
Agrostis capillaris	X	19,5	19,0	- 0,5	20	20	0
Festuca nigrescens	X	8,1	1,9	- 6,2	20	20	0
Poa pratensis	X	0,8	2,8	+ 2,0	6	14	+ 8
Other grasses	X	12,6	5,4	- 7,2	20	20	0
Perennial forage legumes							
Trifolium repens	X	7,9	15,3	+ 7,4	20	20	0
Others families							
Ligusticum mutelina	X	1,8	1,9	+ 0,1	20	20	0
Potentilla ternata	X	1,4	0,8	- 0,6	20	20	0
Taraxacum officinale	X	0,3	2,7	+ 2,4	14	20	+ 6
Others species	X	1,6	0,9	- 0,7	20	20	0
PASTORAL VALUE	**94**	**72**	**81**	**+ 9**	**X**	**X**	**X**

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CONTRIBUTION OF AGRICULTURE TO ROMANIA'S GROSS DOMESTIC PRODUCT

Agatha POPESCU[1]

Rezumat. *Lucrarea a avut ca scop analiza contribuţiei agriculturii la PIB-ul României pe baza datelor statistice oferite de Institutul Naţional de Statistică. Regresia şi corelaţia au evidenţiat că între PIB-ul creat în agricultură şi PIB la nivel naţional există o legatură importantă, care a asigurat creşterea economică ridicată în perioada 2007-2016. Ponderea agriculturii în PIB este 4,6% în 2016 comparativ cu 5,7% în 2007. Creşterea PIB-ului creat în agricultură s-a datorat mai ales producţiei vegetale şi animale. Valoarea producţiei agricole a crescut cu 47,58%, în timp ce producţia vegetală a sporit cu 59,5% şi producţia animală cu numai 30 % în perioada analizată. Producţia vegetală a contribuit cu 60% la valoarea producţiei agricole, în timp ce producţia animală cu numai 33.8%. Agricultura trebuie să continue să se dezvolte acordând atenţie îmbunătăţirii mărimii fermelor, investiţiilor, dotării tehnice şi tehnologiilor moderne care să ducă la creşterea producţiei, productivităţii şi competitivităţii.*

Abstract. *The paper aimed to analyze the contribution of agriculture to Romania's GDP based on the empirical data provided by the National Institute of Statistics. The regression and correlation pointed out that between the GDP created in agriculture and the GDP at the national level there is an important relationship, which assured the higher economic growth in the period 2007-2016. The share of agriculture in Romania's GDP is 4.6% in 2016 compared to 5.7% in 2007. The increase of the GDP created in agriculture is mainly due to vegetal and animal production. The value of agricultural production raised by 47.58%, while the vegetal production value increased by 59.5% and the animal production value by only 30% in the analyzed period. The vegetal production contributed by 60% to the agricultural production value, while animal production by only 33.8%. Agriculture must continue to pay an increased attention to the improvement of farm size, investments, technical endowment and applied technologies to achieve high production, productivity and competitiveness.*

Keywords: agriculture, GDP, GDP in agriculture, agricultural production value, Romania.

1. Introduction

Agriculture is an important branch in Romania's economy providing food and raw materials for households and industry, jobs and activities for the rural population, environment protection and the preservation of rural traditions.

In Romania, agriculture is a way of living in the rural space, and an important income source for the rural population.

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Despite the fact that in Romania there are 3.56 million holdings of a small average size, most of them being subsistence and semi-subsistence farms, just 1% of the holdings being commercial companies working about 48% of the total agricultural land of 13.9 million ha, agricultural production has continuously increased [9].

However, Romanian agriculture has still a low productivity due to the low technical endowment, the reduced use of fertilizers and pesticides, the small surfaces where irrigations are used, the soil degradation, the lack of financial resources and of a functional credit system. The lack of competitiveness is reflected by the low production performance per surface unit and animal, the low product quality which led to a small share of exports of agricultural products and a high share of imports required to cover the needs of the domestic market. For this reason, Romania is a net importing country of agro-food products [6, 12].

In the developed countries, agriculture is a real industrial branch whose competitiveness and stability is sustained by public funds. However, agricultural production is deeply influenced by climate change, price volatility of agricultural products and new energy resources [11]. Despite of the efforts to synchronise agriculture in the EU countries based on the Common Agricultural Policies, there are still significant differences among the Member States [2, 3].

The financial aids allotted to the agriculturists as direct payments within the National Programme of Rural Development have been useful, but not enough. The absorption degree of the funds received from the EU was low in Romania compared to other EU countries [8].

In this context, the paper aimed to analyze the relationship between GDP created in agriculture on Romania's GDP, the evolution of the value of agricultural production by its sources of origin: vegetal production, animal production, and agricultural services in the period 2007-2016 based on the empirical data provided by the National Institute of Statistics. The influence of GDP produced in agriculture on GDP at the national level was studied by means of the regression econometric model and correlation coefficient.

2. Materials and Methods

In order to set up this paper, the empirical data have been collected from the National Institute of Statistics, Tempo online Data base for the period 2007-2016.

The main specific indicators taken into consideration have been the following ones: GDP at national level, GDP created in agriculture, the share of agriculture in Romania's GDP, the value of agricultural production, the value of vegetal production, the value of animal production, the value of agricultural services.

The applied methodology consisted of the following methods:
The Trend method was utilized to identify the direction of the dynamics of a variable in a chronological series of data.
Fixed Index Method was used to emphasize the deviations of each variable value in the analyzed period, based on the formula: $I_{FB} = (X_n/X_{n-1}) *100$, where: X = the variable taken into consideration, n= 1,2,3...i, the years of the chronological series. The year 2007 was considered as reference term.
The statistical parameters: mean, standard deviation, and variation coefficient have been also determined using the well known formulas.
The linear regression model was used to analyze the relationship between GDP cread in agriculture, the independent variable X and GDP at the country level, the dependent variable *Y*, using the regression function: $Y= a + bX$, where: *a* and *b* are the parameters, determined by means of the Least Square Method applied to solve the system of equations.
The Bravais-Pearson correlation coefficient was also used to identify the direction and intensity of the relationships existing between GDP created in agriculture and Romania's GDP.

The results were tabled and graphically designed and also interpreted.

3. Results and Discussions

3.1. The evolution of GDP and GDP in agriculture

Romania's GDP has registered an ascending trend in the analyzed period. It increased by 82.05 % from Lei 418 billion in the year 2007 to lei 761 billion in the year 2016. The economic analysts have appreciated that Romania is the country with the highest economic growth in the EU-28 in the last year of analysis (Fig. 1). The GDP created in agriculture has also increased by 43.09% from lei 23.9 billion in 2007 to lei 35 billion in 2016 (Fig. 2).

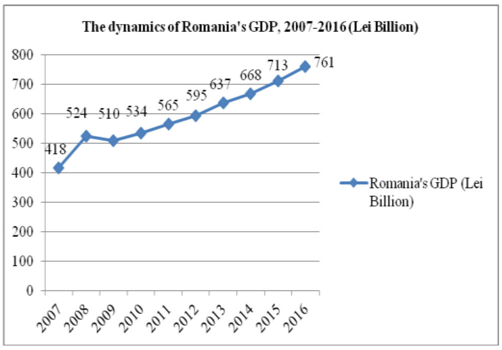

Fig. 1. Evolution of Romania's GDP.
Source: Own design based on NIS data.

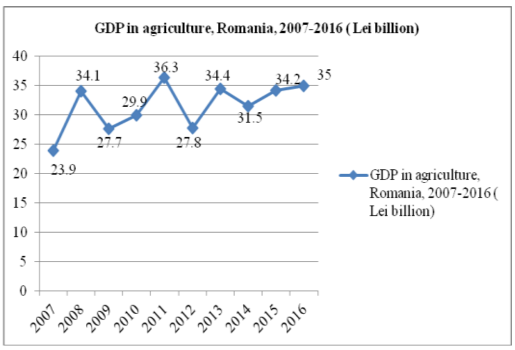

Fig. 2. Evolution of GDP in agriculture.
Source: Own design based on NIS data.

As a result, the share of agriculture in Romania's GDP has recorded a decreasing trend from 5.7% in 2007 to 4.6% in 2016. Even though in 2016, the economic growth in Romania was the highest in the EU, agriculture registered the lowest contribution to GDP in the last 20 years, being of almost 4 times lower than in 1995 [1, 10, 14] (Table 1).

Table 1. The dynamics of the share of agriculture in Romania's GDP in the period 2007-2016 (%)

2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
5.7	6.5	5.4	5.6	6.4	4.6	5.4	4.7	4.7	4.6

Source: Own calculation based on the National Institute of Statistics Tempo online Data base, 2017.

Table 2. The dynamics of the share of agriculture in Romania's GDP in the period 1995-2014 (%)

1995	*2000*	*2001*	*2004*	*2007*	*2011*	*2014*
18.1	10.8	13	12.5	4.8	6.4	4.7

Source: [10].

The evolution of the share of agriculture in Romania's GDP in the period 1995-2016 is presented in Table 2. This decline of the share of agriculture in GDP is not a negative aspect, as in the developed countries this contribution is very small. This means that other economic branches have a higher contribution to the national economy. In 2016, the contribution of the economic branches to the gross value added in Romania's economy was the following: 23.1% industry, 18.1% wholesaling and retailing, vehicle repairs, transport and storage, hotels and restaurants, 5.6% information and communications, 7.4% professional, scientific and technical activities, administrative and support services; 6% constructions; 3.9% agriculture, 3.7% financial transactions and insurances, 8.2% real estate transactions, 10.2% public administration, defence, social insurance, education, health, social assistance, 3.3% shows, cultural and recreation activities, repair works of household appliances and other services [15].

In the case of Romania, even though agriculture contribution to GDP has registered a low level, agriculture productivity is still the lowest in the EU-28 due to the lack of technical endowment, the low investments in this area, the low training level of the farmers, the high number of population dealing with agriculture.

3.2. The evolution of agricultural production value

The increase in absolute figures of the contribution of agriculture to GDP is justified by the growth of agricultural production value. In 2016, the agricultural production value accounted for lei 70.4 billion, being by 4758 % higher than in 2007 (Table 3).

Table 3. The dynamics of the agricultural production value in Romania, 2007-2016 (lei billion)

2007	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
47.7	66.9	59.9	64.4	76.5	64.2	78.4	74.5	68.7	70.4

Source: Own calculation based on the National Institute of Statistics Tempo online Data base, 2017.

The growth of agricultural production value was due to the development of vegetal and animal production in the highest manner and of agricultural services in a smaller way. The vegetal production value increased by 59.58% from lei 28.7 billion in 2007 to lei 28.7 billion in 2016, while the animal production value raised by 30% from lei 18.3 billion in 2007 to lei 23.8 billion in 2016 (Fig. 3 and Fig. 4).

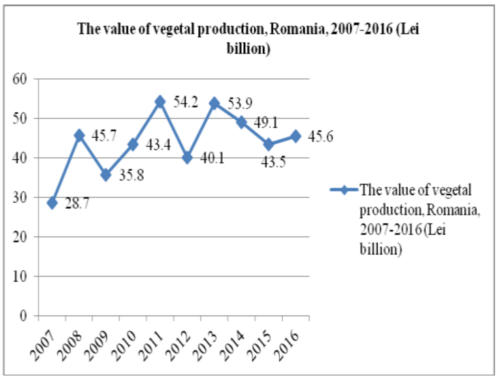

Fig.3.The vegetal production value, 2007-2016.
Source: Own design based on NIS data.

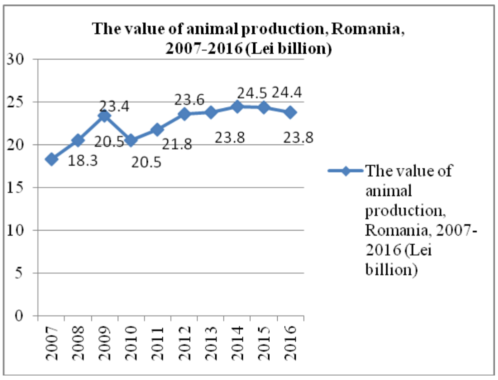

Fig.4. The animal production value, 2007-2016.
Source: Own design based on NIS data.

The value of agricultural services registered only 14.28% increase from lei 0.7 billion in 2007 to lei 0.8 billion in 2016. The agricultural production value in Romania represents 3.4% of the EU agricultural production value. Also, it is 5.4 times lower than in France, 4.1 times lower than in Germany, 3.5 times lower than in Italy, 3.1 times lower than in Spain, 2.1 times lower than in the United Kingdom, 1.9 times lower than in the Netherlands and 1.6 times lower than in Poland (Table 4).

Table 4. Agricultural production value in Romania compared to other EU countries in 2012 (Euro billion)

	EU	*Romania*	*France*	*Germany*	*Italy*	*Spain*	*Netherlands*	*United Kingdom*	*Poland*
Agric. prod.	390.5	13.3	73.0	55.5	46.6	41.4	25.9	28.2	22.5
Crop prod.	208.0	9.1	43.9	27.6	24.9	24.9	12.7	10.9	11.7
Livestock prod	163.6	4.1	25.4	26.0	16.6	16.1	10.3	16.0	10.3

Source: [13].

The increase of agricultural production value in Romania is based on the large used agricultural surface (UAA) accounting for 13.9 million ha, for which Romania comes on the 6th position in the EU after France (29 million ha), Spain (23.6 million ha), the United Kingdom (17.3 million ha), Germany (16.7 million) and Poland (14.4 million ha) [17].

Also, the agricultural production value increased both in the animal and vegetal sector based on the performance in production.

In 2015 compared to the level of 2007, in the vegetal sector, the production increased by: +146.78% for cereals, +161.51% for wheat, +133.1% for maize, +226.3% for sunflower, +39.68% for sugar beet, +16.43% for vegetables, and by +10.05% for fruit. In the animal sector, the production increased by: +329.42% for meat (live weight), +133.79% for milk, + 0.5% for eggs, +6.26% for wool and +88.88% for extracted honey. The only production which declined was the potatoes output (Table 5). Similar results were found by [4, 5, 7].

Table 5. Crop and animal production in Romania in 2015 compared to 2007

	MU	*2007*	*2015*	*2015/2007 %*
Cereals	Thousand tons	7,814.8	19,286	246.78
Wheat	Thousand tons	3,044.5	7,962	261.52
Maize	Thousand tons	3,853.9	8,984	233.1
Sunflower	Thousand tons	546.9	1,785	326.3
Sugar beet	Thousand tons	748.8	1,946	139.68
Potatoes	Thousand tons	3,712	2,625	70.70
Vegetables	Thousand tons	3,116.8	3,629	116.43
Fruit	Thousand tons	1,085.8	1,195	110.05
Meat (live weight)	Thousand tons	333	1,430	429.42
Milk	Tons	21,025	49,156	233.79
Eggs	Thousand pieces	6,522	6,555	100.50
Wool	Tons	21,025	22,343	106.26
Honey	Tons	14,767	27,893	188.88

Source: Own calculations based on [16].

Taking into account these absolute figures regarding the vegetal and animal production, important changes have appeared in the structure of agricultural production value.

While the weight of the vegetal production value in the total agricultural production value increased from 60.1% in 2007 to 65% in the year 2016, with the top share 70.8% in the year 2011, the share of animal production value declined from 38.3% in 2007 to 33.8% in 2016, with the top share 39% in the year 2009 and the lowest share 28.5% in 2011 (Table 6).

Table 6. The share of vegetal production (VP) and animal production (AP) in the agricultural production value in Romania, in the period 2007-2016 (%)

	2007	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***
VP	60.1	68.3	59.7	67.3	70.8	62.4	68.7	65.9	63.3	65.0
AP	38.3	30.6	39.9	31.8	28.5	36.7	30.3	32.8	35.5	33.8

Source: Own calculation based [16].

The low share of animal production in the agricultural production value was due to the reduction of the livestock, mainly of the cattle, pig and poultry livestock, except the sheep and goat livestock which registered an increase.

As a result both milk and meat production was affected by the reduced number of animals and low production performance in terms of milk kilograms per head and average live weight at slaughter.

As a consequence the demand/offer ratio was balanced mainly by imports of food of animal origin to cover consumption requirements.

The agricultural production value is not uniformly distributed in the territory by the 8 micro regions. In 2016, the highest share of the agricultural production value was registered in South Muntenia (19.1%), South East (17.3%), North East (16%), North West (12.6%) and South West Oltenia (11.4%).

The value of vegetal production is the highest in the same micro regions as in the case of agricultural production value as follows: South Muntenia (20.8%), South East (18.7%), North East (14.5%), North West (12%), and South West Oltenia (12%).

The value of animal production is the highest in the following micro regions: North East (19.6%), South Muntenia 916.1%0, Center (14.4%), North West (14.4%) and South East (13.9%).

3.3. The statistical parameters characterizing GDP and agricultural production value

The statistical parameters in terms of mean, standard deviation and the coefficient of variation for the main indicators used in this study are presented in Table 7.

In general, the coefficients of variation registered values below 30% reflecting a good homogeneity degree and representativeness of the mean value.

However, in the case of GDP in agriculture, the value of agricultural production and the value of animal production, the coefficient of variation varied between 0-15%, reflecting that the dispersion of the data is very small and the mean is representative because the data are homogenous.

In the case of Romania's GDP and the value of vegetal production, the dispersion of the data is a medium one and the average is still representative.

Table 7. The statistical parameters of the main indicators of the main indicators

	MU	Mean	Standard deviation	Coefficient of variation (%)
Romania's GDP	Lei Billion	582.5	103.6	17.48
GDP in agriculture	Lei Billion	31.48	4.03	12.80
Value of agricultural production	Lei Billion	67.16	8.99	13.38
Value of vegetal production	Lei Billion	44.02	7.82	17.76
Value of animal production	Lei Billion	22.46	2.08	9.26

Source: Own calculations based on [16].

3.4. The regression of Romania's GDP depending on GDP in agriculture

The regression function estimated between Romania's GDP and GDP in agriculture was the following: $Y = 61.814\,X + 63.204$.

The determination coefficient, $R^2 = 0.427$ reflected that 42.70% of the variation of Romania's GDP is due to the variation of the GDP created in agriculture, the difference of 57.30% variation being determined by other branches of the economy.

This confirms the validity of the regression model (Fig. 5, Table 8).

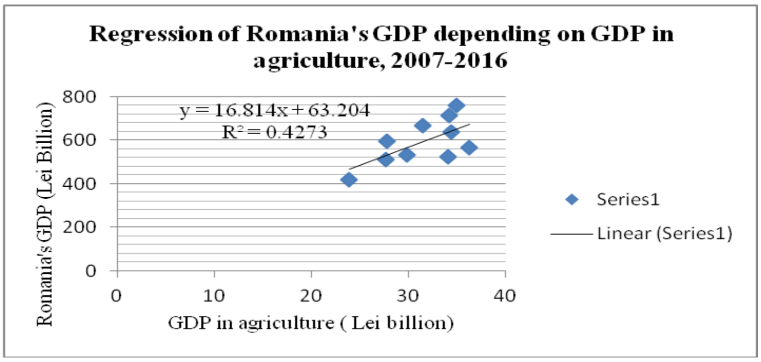

Fig. 5. Regression model regarding Romania's GDP depending on GDP in agriculture.
Source: Own design based on [16].

The Standard Error, St Err = 6.992 reflects the deviation of the observed values from the theoretical value situated on the regression slope. The availability of the regression model is also confirmed by *F*-test= 0.043, this statistical value being higher than the tabled value, as also attested by Sign. *F* = 0.00623. The parameters of the regression model are situated among the following confidence intervals: 440.07 < *a* < 566.47 and 0.943 < *b*< 32.68.

Table 8. The estimated regression model for Romania's GDP depending on GDP in agriculture

Regression statistics						
Multiple R	0.653					
R Square	0.427					
Adjusted R Square	0.355					
Standard Error	83.21					
Observations	10					
ANOVA						
	Df	*SS*	*MS*	*F*	*Significance F*	
Regression	1	41329.82	41329.83	5.968	0.040	
Residual	8	66396.67	6924.58			
Total	9	96726.50				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	63.203	218.244	0.289	0.779	-440.07	566.47
X Variable 1	16.813	6.882	2.443	0.043	0.943	32.68

Source: Own calculation.

The coefficient correlation Bravais-Pearson between the GDP at national level and the GDP in agriculture was R = 0.653 reflecting that the two indicators are positively and strongly correlated.

Conclusions

(1) The GDP created in agriculture has increased in the analyzed period by 43.09%, accounting for lei 35 billion in 2016. As the GDP at the country level recorded a higher growth rate, 82% in the period 2007-2016, the share of agriculture GDP in Romania's GDP declined from 5.7% in 2007 to 4.6% in 2016.

(2) This small contribution is similar to the one achieved in the developed countries, but the low productivity and competitiveness remain the main features of Romania's agriculture. The small holding size, the subsistence and semi-subsistence agriculture technologies, the low technical endowment, low investments, and farmers' training level, the lack of an attractive credit system and the great number of the population dealing with agriculture are still the main restraining factors in the development of a modern and competitive agriculture in Romania.

(3) The value of agricultural production has recorded an ascending trend, reaching lei 70.4 billion in 2016, when it was by 47.58% higher than in 2007. The growth of the agricultural production was due mainly to the development of vegetal production and animal production whose values accounted for lei 28.7 billion and, respectively for lei 23.8 billion in 2016. In the period 2007-2016, the value of the vegetal production increased by about 60%, while the value of animal production raised by about 30%.

(4) The growth of the agricultural production value was determined by the increase in the production level both in the vegetal and animal sectors. But the high growth rate in the vegetal sector has modified the structure of agricultural production in favour of vegetal production. In 2016, the vegetal production accounted for 65% in the agricultural production value compared to only 33.8% in the case of animal production.

(5) Even though the agricultural production value in Romania increased, it has a very small share of only 3.4% in the EU agricultural production value. Therefore, it is very small compared to the one achieved in other Member States.

(6) The regression function estimated between Romania's GDP and GDP in agriculture, reflected that between the two economic indicators exists an important relationship, attested by the determination coefficient which showed that 42.70% of the variation of Romania's GDP is due to the variation of the GDP

created in agriculture. And this was also confirmed by *F*-test and the value of Bravais-Pearson correlation coefficient.

(7) Taking into consideration these results, the economic growth of Romania depends on how all the economic branches, including agriculture, bring their contribution. Agriculture has favourable conditions and a long tradition, but agriculturists must be aware that the organization in associations is compulsory to increase the average farm size, the fixed, working and financial capital, to apply high performance technologies, and grow agricultural production and the quality of the products, to stimulate exports and reduce imports of agro-food products.

(8) The National Programme for Rural Development 2014-2010 provides important measures to encourage and support farmers to improve production, economic efficiency and competitiveness in agriculture.

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EXPENDITURES FOR THE ENVIRONMENTAL PROTECTION IN ROMANIA: RELATIONS AND CONDITIONS IN THE AGRICULTURAL PRODUCTION SYSTEM

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Abstract. *This paper aims to draw attention to one of the forms of pollution generated by the agricultural production system (with reference to soil and groundwater), simultaneously with the need to allocate funding for the expenditures necessary to control these forms of pollution (by means of investment expenditures and internal current expenditures). As a result of the markers analyzed within the data processing, one can infer that in Romania for the dynamics of the period 2008-2015, an increasing trend is displayed for the use of chemical fertilizers in agriculture, alongside a variable level of the expenditures allocated for the prevention and control of the soil and groundwater contamination (pollution). The in-depth analysis of the annual levels and the structure of the expenditures allocated for the prevention and control of the soil and groundwater contamination (pollution) was rendered synthetically by an explicit form, where the following data result: an annual variation of these expenditures, the trend being below the level of the comparison year 2008; the investment expenditures are much higher than the internal current expenditures (the limits of the annual excesses being of 121.00% and 386.41%), an annual increasing trend being remarked. Regarding the structure of the economic agents involved in these prevention activities, it resulted that by means of the ratio of the expenditures made for the prevention activities, the non-specialised producers own the highest ratio of the total (between 79.53 and 97.87% for investment expenditures and between 75.99 and 77.13% for internal current expenditures, respectively). The ones that follow are the specialized producers (with limits between 0.61 and 15.34% for investment expenditures and 11.28 and 42.75% for internal current expenditures, respectively), to which the expenditures made for the public administration are added (in regard to the total of ratios being of 0.37% and 14.70% for investment expenditures and 0.63 and 21.48% for internal current expenditures). The analysis of the levels of the expenses for the prevention and control of the soil and groundwater contamination (pollution) emphasizes/ draws attention to the increasing trend of the quantities of used chemical fertilizers, along with the variational levels, with partial annual decreasing trends, of the investment expenditures and internal current expenditures, differentiated in the structure of the economic agents.*

Keywords: fertilizers, soil pollution prevention and control expenses, prevent and fight soil pollution, producer non-specialized/skilled/public administration, annual rates increasing/decreasing, pollution long/short.

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Introduction

Environment protection is a very important issue of the present stage, when the agri-food system has imperative requirements. But the overall pollution affecting the agri-food system also affects the soil and the underground water.

This happens in an ambivalent way, as input-output: the input of possible infestation caused by the agro-technical interventions/works (especially the use of fertilizers, which affects the soil) and a preservation and transmission of the soil pollution to the agricultural products obtained.

However, the food service of the mankind requires one to know some conditional forms, especially those related to expenses.

Concerning the correlation of the main input-output elements of the pedological system, the present paper tries to highlight the level and the variation of the use of fertilizers and of the investment and current internal expenses needed in order to protect the soil in Romania.

The measurements for the time interval 2008-2015 highlight the level and the annual variations of the forms of fixed and current expenses, which reveal incongruities between the use of fertilizers↔expenses for fighting pollution.

By the discussion on the use of fertilizers, the present paper aims to identify the effects of social and economic policies upon the functionality of the agri-food system.

Materials and Methods

The data on the expenses for preventing and fighting soil pollution is centred on the interpretative forms of the level of the indexes on the use of fertilizers in Romania. For the time interval 2008-2015, the indexes were initially expressed as values and later on as percentage. The relative value was used to identify the variation compared to the year 2008, regarded as reference year, and the comparisons were continued by the structure of the investment expenses and of the current internal expenses. The comparative analyses were also deepened for the situation of the operators involved in the consumption of these expenses, which, according to CAEN Rev. 2, are classified as: non-specialised producers (carrying out activities of environment protection as second or auxiliary activities, whereas their main activity is not of environment protection), specialised producers (whose main activity consists of environment protection) and public administration (whose activities of “non-market” environment protection is performed for individual and collective consumption).

Results and Discussions

The use of fertilizers is a first-rank agri-technical measure for obtaining competitive agricultural productions. However, the excessive use of fertilizers has serious effects at social and economic level. The present paper started from these premises and analysed both the dynamics of the use of fertilizers and the structure of the investment expenses and of the current internal expenses made for preventing and fighting the pollution of soil and underground water.

I.- The dynamics of the fertilizers used in the agricultural system of Romania.
The use of fertilizers in Romanian agriculture has variational levels related to the agrarian reform that made radical changes in the structure and the way in which the soil is used. A large variety of property and household forms has emerged, and the result is that the land has split into a plethora of small plots of lands. The quantitative levels displayed in Table 1, for the dynamics of the interval 2008-2015, lead to the following remarks:

Table 1. The structure of fertilizers used in the Romanian agriculture

The structure of the fertilizer types	U. M.	2008	2009	2010	2011	2012	2013	2014	2015
TOTAL	thousand tons (s. a.)	398	426	481	487	438	492	452	522
	% of the year 2008	100	107.03	120.85	122.36	110.05	123.61	113.56	134,19
Nitrous	thousand tons (s. a.)	280	296	306	313	290	344	303	349
	% of the year 2008	100	105.71	109.28	111.78	103.57	122.85	108.21	124,54
Phosphatic	thousand tons (s. a.)	102	100	123	126	113	114	119	131
	% of the year 2008	100	98.03	120.58	123.52	110.78	111.76	116.66	128,43
Potash	thousand tons (s. a.)	16	30	52	48	35	34	30	42
	% of the year 2008	100	187.5	325	300	218.75	212.5	187.5	262, 50

Source: INS România, Anuarul Statistic al României, INS, 2015

- the total amounts of fertilizers used in the Romanian agriculture has a variational pattern, with an ascending trend compared to the reference year 2008. It is worth mentioning the interval 2012-2014, which shows a decrease compared to the previous years.

- the structural analysis of the main types of fertilizers leads to the conclusion that nitrous fertilizers have the largest share, followed by the phosphatic and the potash ones. The annual growth rates are, however, different, if they are compared to the same reference year 2008. The highest growth rate is found for potash fertilizers (which are used several times more than in the reference year), followed by the phosphatic and the nitrous ones (whose growth rates are of about 0.10% ... 0.20%).

The results of the analysis of the use of fertilizers reveal the marked quantitative level, besides the qualitative aspect that refers to the annual growth trend of use, even on the agricultural properties that are small. Nevertheless, the excessive use of fertilizers always has negative effects too, especially on the soil fertilization/pollution. This is why measures of preventing and fighting pollution are needed, both long-term and short-term ones. In this context, one may make remarks on the expenses, both investment and current internal ones.

2.- Investment expenses made for preventing and fighting the pollution of soil and underground water

Investment expenses belong to the long-term measures and are one of the most important aspects of the prevention and fighting the pollution of soil and underground water. The analysis of these expenses was performed at national level, using the value quantum, as well as a valued expression of the structure of the economic agents (non-specialised, specialised and public administration).

All these problems related to the total investment expenses made for preventing and fighting the pollution of soil and of underground water are summed up in Table 2 and entailed the following conclusions:

Table 2. Overall investment expenses made for the prevention and fighting the pollution of soil and underground water in Romania

Specification	U.M.	2008	2009	2010	2011	2012	2013	2014	2015
TOTAL out of which:	thousand lei current prices	360468	282997	333749	192899	257166	250018	220678	366781
	% of the year 2008	100	78.50	92.58	53.51	71.34	69.35	61.21	101.75
	% of the annual total (100%)	100	100	100	100	100	100	100	100
	% of the total current internal expenses	134.79	220.58	367.38	121.00	386.41	360.70	351.28	333.47
Non-specialised producers	thousand lei current prices	298215	225065	251920	159997	241702	244704	212030	348564
	% of the year 2008	100	75.47	84.47	53.65	81.04	82.05	71.09	116.88
	% of the annual total (100%)	82.73	79.53	75.48	82.94	93.99	97.87	96.08	95.03
	% of the total current internal expenses	127.74	230.84	567.51	194.81	557.84	515.28	437.59	514.06

Specialised producers	thousand lei current prices	12915	16330	51209	27879	2756	4399	1948	2243
	% of the year 2008	100	126.44	396.50	215.86	21.33	34.06	15.08	17.36
	% of the annual total (100%)	3.58	5.77	15.34	14.45	1.07	1.76	0.88	0.61
	% of the total current internal expenses	42.80	61.54	131.86	42.72	12.22	20.56	16.04	12.09
Public administration	thousand lei current prices	49338	41602	30620	5023	12708	915	6700	15974
	% of the year 2008	100	84.32	62.06	10.18	25.75	1.85	13.57	32.37
	% of the annual total (100%)	13.69	14.70	9.18	2.61	4.94	0.37	3.04	4.36
	% of the total current internal expenses	1299.05	975.19	401.73	41.77	1891.07	211.31	301.39	67.60

Source: INS România, Anuarul Statistic al României, INS, 2015

- the range of the overall investment expenses is, for most years, under the level of the year 2008, except for the last year of analysis. The percentage limits in the comparison against the year 2008 are between 53.51% and 92.58%. The comparison made as regards the total current internal expenses of the reference year 2008 reveals that they are three times higher;

- the non-specialised producers keep a rate that is similar to the annual dynamics of the investment expenses. It is worth mentioning that the non-specialised producers have an annual quantum that makes up a majority of the total investments (between 75.48% and 97.87%), whereas compared to the total current internal expenses the growth rates reach a level of 514.06%;

- concerning the investment expenses of the specialised producers one may note a strong annual decrease compared to the year 2008. A low level is found both for the total expenses (between 0.88 and 15.34%) and for the total current internal expenses (between 12.09 and 61.54%).

- as for the investment expenses made by the public administration and related to the pollution of soil and of public water, one may remark a descending trend (against the reference year 2008, a form that is also preserved when comparing the total in the annual dynamics). A comparison between the investment expenses made by the public administration and the total current annual expenses reveals the same high shares.

3.- Current internal expenses made for preventing and fighting the pollution of soil and underground water.

These types of expenses include the prevention and fighting of pollution and refer to the structure and evolution of the levels for which Romania has a certain specificity. The dynamics of the interval 2008-2015 is analysed starting from the annual valued levels displayed in Table 3 and leads to the following conclusions:

Table 3. Total current internal expenses made for preventing and fighting the pollution **of soil** and underground water in Romania

Specification	U. M.	2008	2009	2010	2011	2012	2013	2014	2015
TOTAL out of which:	thousand lei current prices	267421	128295	90845	159410	66552	69313	62820	109987
	% of 2008	100	47.97	33.97	59.61	24.88	25.91	23.49	41.12
	% of annual total (100%)	100	100	100	100	100	100	100	100
	% of total investment expenses	74.18	45.33	27.21	82.63	25.87	27.72	28.46	29.98
Non-specialised producers	thousand lei current prices	233451	97497	44390	82126	43328	47489	48454	67805
	% of 2008	100	41.76	19.01	35.17	18.55	20.34	20.75	29.04
	% of annual total (100%)	87.30	75.99	48.86	51.52	65.10	68.51	77.13	61.65
	% of total investment expenses	78.28	43.31	17.62	51.32	17.92	19.40	22.85	19.45
Specialised producers	thousand lei current prices	30172	26532	38833	65259	22552	21391	12143	18552
	% of 2008	100	87.93	128.70	216.28	74.74	70.89	40.24	61.48
	% of annual total (100%)	11.28	20.68	42.75	40.94	33.89	30.86	19.33	16.87
	% of total investment expenses	233.61	162.47	75.83	234.07	818.28	486.26	623.35	827.10
Public administration	thousand lei current prices	3798	4266	7622	12025	672	433	2223	23630
	% of 2008	100	112.32	200.68	316.61	17.69	11.40	58.53	622.16
	% of annual total (100 %)	1.42	3.33	8.39	7.54	1.01	0.63	3.54	21.48
	% of total investment expenses	7.69	10.25	24.89	239.39	5.28	47.32	33.17	147.92

Source: INS România, Anuarul Statistic al României, INS, 2015.

- the variation levels for the total current internal expenses, compared to the year 2008, reveal a descending trend which reaches a minimal level of 23.49% of the year 2008, in the year 2014. For the same dynamics, the structural level of the total investment expenses has a descending trend whose limits are between 74.18% in the year 2008 and only 29.98% in the year 2015;

- the current internal expenses made by the non-specialised producers has the same decrease compared to the year 2008. One may notice that the non-specialised producers have the largest share of the total internal expenses (between 48.86% and 77.13%), but a significantly smaller share of the total investments made by the non-specialised producers for the same respective group (between 17.52% and 78.28%);

- the level of the total internal expenses made by the specialised producers has annual variations, which have a descending trend compared to the year 2008. Moreover, the share of these expenses in the annual total current expenses ranges between 19.33% and 42.75%, but is considerably higher in the total investments (between 75.83% and 827.10%).

- the current internal expenses made by the public administration have the lowest values and a share which fluctuate against the level of the year 2008 (between 11.40% in 2013 and 622.16% in 2015). When compared to the annual total of these expenses, the levels of the expenses made by the public administration are the lowest ones (between 1.01% and 21.48%). Significant variations are noticed for the percentage of the total investment expenses (between 5.28% and 239.39%).

To sum up, the dynamics analysed reveals a much lower level of the current internal expenses, a prevalence of these expenses for the non-specialised producers, with value levels and comparative-percentages levels marked by variations during the year.

Conclusions

The pollution of soil and of underground water caused by the use of fertilizers in Romania is a problem with serious effects on the agricultural production system. The analyses carried out during the last eight years on the comparative levels of the fertilizer quantities correlated with the expenses for the protection of the soil and the underground water lead to the following conclusions:

1.- The quantities of fertilizers used in Romanian agriculture, dynamically analysed, have an ascending trend (one may mention the existence of an annual variation, prevalent for the nitrous fertilizers).

2.- The investment expenses made for preventing and fighting the pollution of soil and underground water are prevalent overall, but they also have annual variations and descending annual trends (against the reference year 2008). Moreover, the largest share of these expenses belongs to non-specialised producers.

3.- The current internal expenses made for preventing and fighting the pollution of soil and underground water have annual levels that are significantly lower than those of the investments. The same prioritised allocation is found for non-specialised producers.

4.- The paper sums up the quantitative aspect of the use of fertilizers as well as a diminished structure of the investment expenses and of the current internal expenses made for preventing and fighting the pollution of soil and underground water. However, the increased use of fertilizers causes a damage of the soil features, especially of the fertilization ones.

Closely related to this problem emerges the necessity of taking measures of preventing and fighting both short-term and long-term pollution, with particular reference to the allocated funds. This, in its turn, requires the increase of fund allocation for preventing pollution, but also a balancing of the structure of these funds between three parts: non-specialised producers, specialised producers and public administration.

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CORRELATION RHYTHMS ON THE APPLICATION OF CHEMICAL FERTILIZERS/PESTICIDES AND THE EXPENDITURE ALLOCATION FOR POLLUTION PREVENTION AND CONTROL IN THE SOIL AND GROUND WATER OF ROMANIA

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Keywords: chemical fertilizers, pesticides, soil pollution, capital expenditure / current, standard deviation, coefficient of variation, dispersion, regression equation.

Cuvinte-cheie: îngrășăminte chimice, pesticide, poluare a solului, cheltuieli de investiții/curente interne, abatere standard, coeficient de variație, dispersie, ecuație de regresie, determinație.

Abstract. *The present work is the result of a pertinent analysis and highlights the results regarding both the first variational existing level of application of chemical fertilizers/pesticides, and the level of expenses made in order to prevent and fight soil and ground water pollution in Romania. The statistical results on variability were rendered by statistical indexes which were based on the data corresponding to the interval 2008-2015. The main values are the average, the standard deviation and the coefficient of variation. All this enabled us to calculate the annual growth rate. We monitored the variation results of the influence factors, which methodologically using forms of regression equations ($y = a \cdot x$) showed the influence of the use of fertilizers / pesticides (x) on the expenses made in order to combat pollution (y). The variations in amplification by means of ± 5% ± 50% x, variations enabled us to sequentially identify the presumptive levels of domestic investment expenses and current (y). The overall results were also founded upon knowing the percentage changes of the elasticity. We have found out that there is an inadequate level of expenditure allocation for fighting pollution in relation to the increased use of fertilizers/pesticides.*

Introduction

The use of chemical fertilizers and pesticides is regarded as a fundamental agrotechnical link, whose popularity suggests the necessity of knowing its implications in various areas of economy and society. A constant and important problem is the triple relationship between pollution, control expenses and human protection. The present paper analyses the necessity and rhythm of the expenses needed for controlling soil pollution by using chemical fertilizers and pesticides in agriculture.

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The use of the prospective forms resulted from regression equations led to the identification of relations between the present level of using fertilizers/pesticides and the soil protection expenses used nationwide. These were highlighted using the variation levels of the use of fertilizers/pesticides by means of regression equations regarded as specific correlative forms. The analysis has led to the conclusion that the present expenses are insufficient and they must be raised (both the investments and the current internal ones) in order to prevent and fight the pollution of Romania's soil and ground water.

Materials and Methods

The methodology employed in the present paper aims to use the most appropriate systems of highlighting the analysed problem. The initial data are the levels of using fertilizers/pesticides and the expenses made for preventing and fighting the pollution of the soil and of the ground water in Romania during the interval 2008-2016. The data processing leading to the mapping of the relations and conditions concerning the budgeting the prevention and the fighting of soil and ground water pollution as an effect of the use of fertilizers was structured two-dimensionally.

Several indexes were used in the analysis of the fertilizers quantities and of the protection expenses allocated, in order to follow the fluctuations occurring during the time interval that was investigated. These indexes were the result of the average values, standard deviation, coefficient of variation and determination, which enable us to identify the annual growth rate.

As long as all these observations were considered to be static forms during the interval analysed, the results were known by analysing the influence factors. The methodology made use of regression equations ($y = a \cdot x$) and framed the relations between the quantities of fertilizers/pesticides used and the expenses made for them. In such cases, the determinant factor (x) was made up by the allocated quantities and the resultant factor (y) by expenses made for protecting the soil and the ground water. Starting from the annual differentiation of the fertilizers/pesticides depending on the variations of the amplification by the ±5% x and ±.50% x variations, we identified the presumptive levels of the investment expenses and of the internal expenses (y). The overall results were based on finding out the differences between Y adjusted (with +5%x and +10%x) and Y with initial/brute values (of the year 2015). All these were completed with the percentage variations of the quotient of elasticity, correlation and determination. By the way the statistical determination (R2) was interpreted, the share of the simultaneous influence of all the factorial variables (the use of fertilizers/pesticides) out of the overall variation of the resultant variable (allocating the investment expenses/current internal expenses).

Results and Discussions

The growth of the agricultural productions based on chimisation is a problem that permanently involves both the modalities and the quantitative level and the investment and current expenses caused by the quantitative amplification made for fighting the possibly occurring pollution. This aspect is analysed nationwide, covering the time interval 2008-2015, and expressed in quantitative values starting from the annual variations. Moreover, some presumptive situations are also analysed.

I. - The quantitative level and the variation system of the use of fertilizers/pesticides and of allocating expenses for preventing and fighting the pollution of soil and ground water in Romania.

The analysis of the use of fertilizers/pesticides and of allocating expenses for preventing and fighting pollution is rendered for the whole country both in their evolution and in the variation system made up starting from statistical indexes. The values displayed in Table 1 lead to the following conclusions:

Table 1. The use of fertilizers/pesticides and the budgeting of expenses for the prevention and fighting of the pollution of soil and ground waters in Romania.

Specification	Total *fertilizers used*	Total *pesticides used*	*Investment expenses* (for preventing and fighting the pollution of soil and ground water)	*Total internal expenses* (for preventing and fighting the pollution of soil and ground water)	
U. M.	thousand tons (s. a.)	thousand tons (s. a.)	thousand lei (current prices)	thousand lei (current prices)	
2008	397.965	7.193719	360468	267421	398
2009	426.207	6.548733	282997	128295	426
2010	480.586	7.249206	333749	90845	481
2011	486.944	6.582935	192899	159410	487
2012	437.972	6.418796	257166	66552	438
2013	491.831	6.947877	250018	69313	492
2014	452.239	6.723793	220678	62820	452
2015	532.702	6.608037	366781	109987	522

Indexes concerning the level of the variational system for the interval 2008-2015

average	463.3	6.8	283094.5	119330.4
standard deviation	42.9	0.3	64756.0	68657.5
Coefficient of variation (%)	9.26	4.58	22.87	57.54
annual growth rate (%)	4.25	-1.21	0.25	-11.92

- the use of fertilizers and pesticides is different as to its annual rhythm but has different trends. One may remark that fertilizers have a growing trend whereas pesticides have a regressive one.

- the expenses allocated, both the invested ones and the current internal ones, have also annual variations, but also with differentiated trends. Thus, the investment expenses are much higher than the current ones, which have a regressive trend up to the year 2014; the current internal expenses have a definite regressive trend with a minimum identified for the year 2014.

- the results of the statistical indexes for the annual differentiation of the quantities of fertilizers/pesticides and the respective expenses are compared to their average values on the analysed time interval. They led to the following conclusions: the standard deviation has values which are very different from the average; the variation quotient, calculated as the difference between the standard deviation and the average value, shows that the percentage values are not favourably grouped around the average values; the growth rate is the result of the influence made by all the causes and conditions that cause the growth of the quantities of fertilizers/pesticides used, which leads to a growth (that can be described as slightly significant) of the use of fertilizers only, an insignificant growth of the investment expenses, as well as decreases of the current internal expenses for using pesticides.

The analysis done synthetically suggests a differentiation of the growth, which means that an increase of 4.24% in the use of fertilizers corresponds to an increase of 0.25% of the investment expenses and a decrease of -11.92% in the current internal expenses.

2. - *The variations of the quantities of fertilizers/pesticides according to the sequential forms of design*.

An intermediate stage consists of the time grading of the structure, which can be rendered sequentially for the levels of fertilizers/pesticides. The variations of +5% *x* and +10% *x* reveal an increase of the initial level for each type of fertilizer. Table 2 displays these levels for each variational form. The quantitative values (thousand of tons, etc.) are thus expressed by successively amplifying these alterations, whereas the variational forms are needed in order to estimate the presumptive expenses. By modifying the *x* factor while keeping the other factors constant, structural modifications result. These modifications are summed up in the regression equation and will influence the presumptive variations of all the protection expenses. These expenses were taken into account both as investment expenses and as current internal expenses.

Table 2. Sequences of the quantitative differentiations for fertilizers/pesticides (in relation to the variations of the amplifications +5%*x* and +10%*x*)

Variational amplification of the *x* factor (+5%x and +10%*x*)	The structure of the quantities of fertilizers/pesticides in relation to the designed variations (thousand tons s.a.)					
	Nitrous x_1	Phosphatic x_2	Potash x_3	Insecticide x_4	Fungicide x_5	Herbicide x_6
X_1+5%	**375.220**	132.657	42.693	0.716	2.246	3.646
X_2+10%	**393.087**	132.657	42.693	0.716	2.246	3.646
X_1+5%	357.352	**139.290**	42.693	0.716	2.246	3.646
X_2+10%	357.352	**145.923**	42.693	0.716	2.246	3.646
X_1+5%	357.352	132.657	**44.828**	0.716	2.246	3.646
X_2+10%	357.352	132.657	**46.962**	0.716	2.246	3.646
X_1+5%	357.352	132.657	42.693	**0.752**	2.246	3.646
X_2+10%	357.352	132.657	42.693	**0.788**	2.246	3.646
X_1+5%	357.352	132.657	42.693	0.716	**2.358**	3.646
X_2+10%	357.352	132.657	42.693	0.716	**2.471**	3.646
X_1+5%	357.352	132.657	42.693	0.716	2.246	**3.828**
X_2+10%	357.352	132.657	42.693	0.716	2.246	**4.010**

The amplification was calculated for the last year – 2015.

3. - Presumptive variations of the investment expenses made for preventing and fighting the pollution of soil and ground water

For the investment expenses, a delimitation was possible by using the most adequate regression equation. These expenses were rendered in an adjusted form, their presumptive levels being filled up with the difference to the real (initial) data and the form of elasticity. This structural set led to the conclusions summed up in Table 3.

Table 3. Sequential differentiations of the **investment expenses** caused by the variations of the amplification level (+5% and +10%) by using fertilizers/pesticides [using the regression function: Y(invest. expenses, thousand lei) = -725144+ 1077,173 x_1+ 11654,45 x_2 -16327,9 x_3 + 483800,7 x_4 + 12177,96 x_5 - 152501 x_6 (R^2 = 0,5829; r = 0,76)]

Type of fertilizer/ pesticide	Name of the fertilizer type (in the regression equation)	Variational levels of the fertilizer/pesticide type	Levels of the variable amplification (thousand tons)	*Y adjust.* investment expenses (data entered in the calculation with +5%/....+10%) thousand lei	Difference (from Y adjusted with +5%/....+10%) and Y adjusted with initial/brutto data)	Elasticity (%)
Nitrous	X_1	+5% x_1	375.220	345944	19246	5.9
		+10% x_1	393.087	365191	38493	11.8
Phosphatic	X_2	+5% x_2	139.290	404000	77302	23.7
		+10% x_2	145.923	481302	154604	47.3
Potash	X_3	+5% x_3	44.828	3.646	-34854	-10.7
		+10% x_3	46.962	3.646	-69709	-21.3
Insecticide	X_4	+5% x_4	0.752	344025	17328	5.3
		+10% x_4	0.788	361353	34655	10.6
Fungicide	X_5	+5% x_5	2.358	328065	1368	0.4
		+10% x_5	2.471	329433	2735	0.8
Herbicide	X_6	+5% x_6	3.828	298900	-27797	-8.5
		+10% x_6	4.010	271103	-55595	-17.0

- the presumptive level of the investment expenses analysed by the structural level of the output of the regression equation has different values, which, compared to the effective (initial) values can be delimited as follows: adjusted values that reveal a level which is superior to the initial expenses — this is the case of most types of fertilizers/pesticides; for the case of phosphatic and herbicide fertilizers the amplification of the expenses leads to an adjusted level of expenses that is smaller than the initial one;

- the elasticity, which signals the limits of the ratio between the modification of the expense level and the modification of the quantities of the fertilizers used, has structures that are similar (positive/negative) to the level of the fertilizers/pesticides used;

- The value of the **index of determination** expresses the intensity of the direction of simultaneous influence between the quantities of fertilizers/pesticides used and the investment expenses made for protecting the soil. The determination (R^2=0,5829) expresses an average causal relation, **because the share of the influence of the factorial variables in the total variation of the resultant variable is an average value, respectively a form of an average correlation, which is also rendered by the value of the correlation index.**

The analysis of the variations of the presumptive levels of the investment expenses made for the protection of the soil enables the inference of the variational correlative directions of the amounts, but also incongruities related to the use of phosphatic and herbicide fertilizers.

4. - Presumptive variations of the current internal expenses made for preventing and fighting the pollution of soil and ground water in Romania.

The current internal expenses made for fighting the pollution of soil express the allocation of annual funds which are lower than the investment expenses, but which show a similar behaviour of the annual differentiations. The strong influence is expressed by the same variables that express the use of fertilizers/pesticides and for which the regression functions delimit the adequate sequences. The variational levels +5% and +10% of each type of fertilizers determine the adjusted current values of the current internal expenses. These results are shown in Table 4 and lead to the following conclusions:

Table 4.- The sequential differentiations of the **current internal expenses** determined by the variations of the level of amplifications (+5% and +10%) by using fertilizers/pesticides [using the regression function: *Y*(current internal expenses, thousand lei) = *Y*(current expenses, thousand lei) = -1366448+739,63 x_1 + 27515,9 x_2 - 37953,8 x_3 + 989561,3 x_4 - 442049 x_5 - 142357 x_6 (R^2 = 0,951; r = 0,975)]

Type of fertilizer/ pesticide	Name of the fertilizer type (in the regression equation)	Variational levels of the fertilizer/pesticide type	Levels of the variable amplification (thousand tons)	*Y adjust.* investment expenses (data entered in the calculation with +5%/....+10%) thousand lei	Difference (from *Y* adjusted with +5%/...+10%) and Y adjusted with initial/ brutto data)	Elasticity (%)
Nitrous	X_1	+5% x_1	375.220	137830	13215	10.6
		+10% x_1	393.087	151045	26431	21.2
Phosphatic	X_2	+5% x_2	139.290	307123	182509	146.5
		+10% x_2	145.923	489632	365018	292.9
Potash	X_3	+5% x_3	44.828	43596	-81018	-65.0
		+10% x_3	46.962	-37422	-162036	-130.0
Insecticide	X_4	+5% x_4	0.752	160056	35442	28.4
		+10% x_4	0.788	195498	70883	56.9
Fungicide	X_5	+5% x_5	2.358	74968	-49646	-39.8
		+10% x_5	2.471	25322	-99293	-79.7
Herbicide	X_6	+5% x_6	3.828	98666	-25948	-20.8
		+10% x_6	4.010	72718	-51897	-41.6

- the adjusted level of the current internal expenses has positive values in most of the sequences analysed. Only the use of potash fertilizers (+10% *X*3) leads to a negative value. The differences form the initial values (the actual expenses) lead to negative values for the use of fertilizers of the potash, fungicide and herbicide types.

- concerning elasticity, the amplitudes are very large. The positive variations include positive percentage levels (between 10.6% and 292.9%) for nitrous, fungicide and herbicide fertilizers. The analysis of the mentioned levels reveals a typological variety that includes the modification of the economic variable (current expenses made for soil protection) for the simultaneous or anterior use of fertilizers/pesticides. Despite the fact that the values resulted from the analytic calculus, explaining the analysed structure, should be in a natural relationship, there is both elasticity (for nitrous, phosphatic and insecticide) and inelasticity (for potash, fungicide and herbicide).

- concerning the correlative trends expressed by the index of determination (R^2 = 0,951) and correlation (r = 975) there is a significant intensity of the relation between the use of fertilizers/pesticides and the allocation of current operational expenses for soil protection. This is due to the fact that the share of the influence of the factorial variables (the use of fertilizers/pesticides) in the total variation of the resultant variable (the allocation of current internal expenses) is large, which proves the existence of a strong multiple correlation.

The levels displayed by the sequential evaluations reveal the disorder that may occur in the relation between the use of fertilizers/pesticides and the allocation of expenses. All these are analysed using the variation levels and the amplitudes resulted from the calculi.

Conclusions

The analytic elements served to monitor the relations and the conditioning existing between the necessity of allocating funds for the prevention and fight of the pollution of soil and ground water caused by the use of fertilizers/pesticides in the whole country. The level of the indexes revealed the correlative rates and led to the following conclusions:

1- The growth rate of the agricultural production has a general trend, but one has to take into account the influences exerted by the increased use of fertilizers/pesticides upon the necessity of allocating expenses for protecting the soil and the ground water. The dynamic processes analysed revealed the existence of different growth rates. Thus, the quantitative use of fertilizers/pesticides has a growth of 4.24% while the investment expenses made for protecting the soil and the ground water have a growth of 0.25% and the current internal expenses go down to a level of -11.92%.

2- Concerning the quantitative evolution described using statistical indexes, one may see an ascending trend for the use of fertilizes, whereas the pesticides have a descending trend. The investment expenses are much higher than the current internal ones. The annual differences for the quantities of fertilizers/pesticides and for the expenses, using the average values of the analysed time interval, show standard deviations very different from the corresponding average values, which means that the growth rates are very different.

3- The variational influence of amplifying the use of fertilizers/pesticides (+5%x and +10%x) upon the investment expenses leads to a level of expenses that is higher than the initial expenses. The variations of the structures of the quantities of fertilizers/pesticides according to the presumptive sequential forms (+5% x and +10%

x) expressed by the results of the regression equation reveal an increase of the initial level of expenses for each type of fertilizer. The values of the correlation ratio reveal an influence exerted by the quantities of fertilizers/pesticides used and the investment expenses made for soil protection. Concerning the causal relation (according to the correlation ratio) one may notice the existence of a weak influence of the quantities of fertilizers/pesticides used upon the investment expenses made for soil protection. There are correlative variational directions of the values, but there are also incongruities in the cases of the potash fertilizers and herbicides.

4- The presumptive variations of the use of fertilizers/pesticides and of the allocation of internal expenses for preventing and fighting the pollution of soil and ground water have the same annual variational form, but at a level which is lower than the investment expenses. The adjusted values of the current internal expenses were identified within adequate sequential limits, according to the variational levels of +5% and +10% of each type of fertilizer/pesticide. The current internal expenses have an adjusted level rendered by positive values and present in most sequences, but also by negative values for the potash fertilizers, fungicides and herbicides. Concerning elasticity, the amplitudes are very large and a typological variety that includes the modification of the economic variable (current expenses made for soil protection) for the simultaneous or anterior use of fertilizers/pesticides — elasticity for nitrous and phosphatic fertilizers and for insecticides, but inelasticity for potash fertilizers, fungicides and herbicides).

The analysis of the levels of the determination index reveals the existence of a different intensity for the link between the use of fertilizers/pesticides and the allocation of expenses. For the investment expenses (as a resultant variable) the share of the influence of the factorial variables in the total variation of the resultant variable has a medium value (R^2=0.5829). For the current internal expenses, by the influence of the variables, this relation is significant (R^2 =0.951) and has a strong multiple correlation. The levels, variations and amplitudes resulted from the calculi express the correlative trends which reveal an intensity direction of the relation between the use of fertilizers/pesticides and the allocation of funds for soil protection.

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Fig. 1.- The dynamics of the expenses made for preventing and fighting the pollution of soil and of underground water in România (thousand lei)

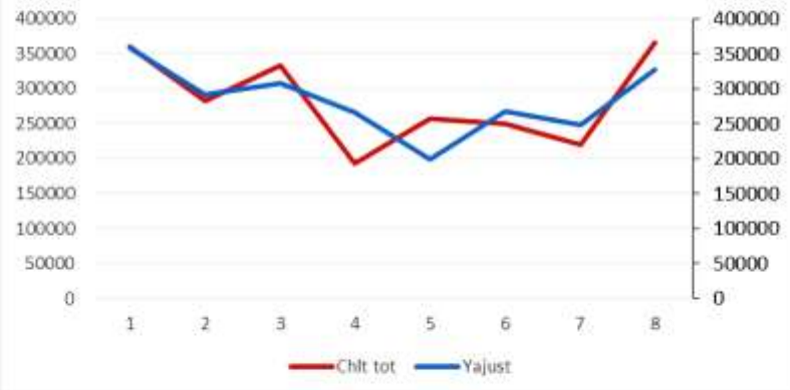
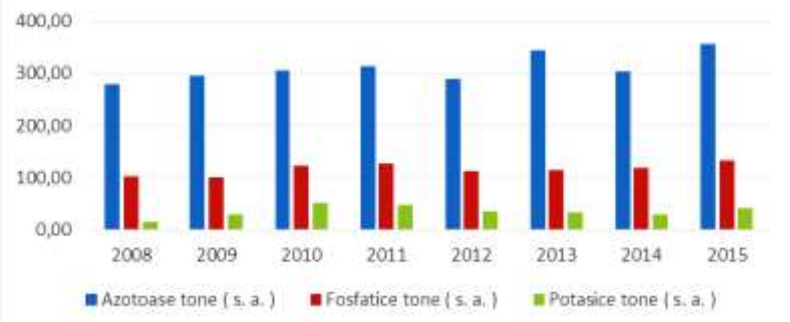


Fig. 2.- Quantities of fertilizers used in Romania



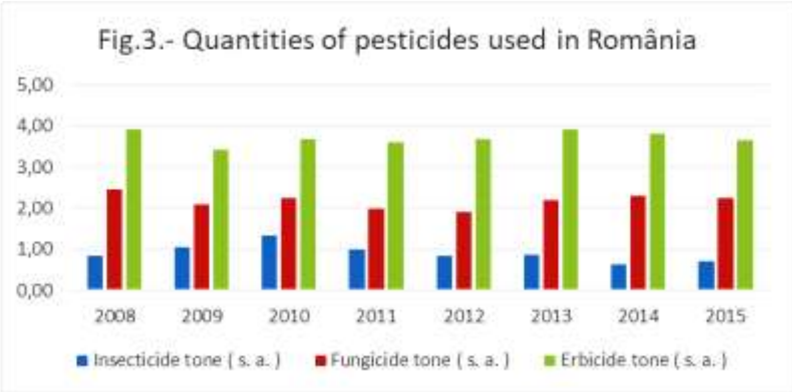


Fig.3.- Quantities of pesticides used in România
5,00
4,00
3,00
2,00
1,00
0,00
2008
2009
2010
2011
2012
2013
2014
2015
Insecticide tone (s. a.)
Fungicide tone (s. a.)
Erbicide tone (s. a.)