Annals of the Academy of Romanian Scientists
Series on Agriculture, Silviculture and Veterinary Medicine Sciences
Online ISSN 2069 – 1149 Volume 4, Number 1-2/2015

THE EVOLUTION OF THE AVERAGE YIELD PER HA IN THE MAIN CROPS DURING THE PERIOD OF PLANNED ECONOMY

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Abstract: *During the planned economy period (1950-1989), the Romanian agriculture benefited from the allocation of an important volume of resources, which, associated with the advantages of scale economy, led to a positive evolution of the main qualitative performance indicator – the average yield per surface unit.*

Regarding the evolution of the average yield, given the general ascending trend, the differences among crops or groups of crops remained the same until the end of the period. In others, among which maize, oleaginous plants, sugar beet or potatoes, the level of the average yields manifested an obvious decreasing trend over the last few years of planned economy.

In spite of the success obtained, compared to the market economy system, the negative differences remained significant. During the last years of planned economy, in Romania, compared to France, for example, the yield was by almost 30% lower in wheat, by 45% lower in maize, by less than 50% lower in soy or three times lower in sugar beet or potatoes, which were cultivated exclusively on irrigated fields.

Keywords: agriculture, average yield, planned economy.

1. The yield of cereals

The Romanian agriculture was, in its entire history, a cereal-based one. However, during the planned economy period, the share of the cereals cultivated on arable land reduced from 75 % to 61 %, with some variations from one period to another, the main breeds being wheat and maize, followed by barley (Table 1).

Compared to the previous period of the Second World War, the area planted with cereals reduced in those breeds grown for feeding draft animals (barley, oats, maize), their place being taken by non-food crops.

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Table 1. The evolution of the area cultivated with cereals, in Romania, during 1934-1938 and 1951-1990 -thousand ha-

Specification	1934-1938	1951-1955	1956-1960	1961-1965	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990
Total cereals	*8186*	*6971*	*7312*	*6772*	*6509*	*6068*	*6353*	*6174*	*5785*
Arable share	*87,1*	*73,3*	*75,0*	*69,1*	*66,5*	*62,5*	*64,8*	*62,4*	*60,8*
- wheat + rye	2742	2956	3069	3054	2826	2463	2297	2276	2403
-barley+two-row barley	839	472	290	237	278	363	662	791	725
- maize	3884	3057	3613	3308	3246	3110	3295	2992	2685
- oats	674	449	314	150	132	102	51	71	97
- rice	0,4	18	19	14	25	25	21	28	45
- sorghum+millet	46	19	6	9	3	4	17	15	9

Source: The Statistical Yearbook of Romania, CNS data.

Against the background provided by the absolute ponderal decrease in the cultivated land area, the cereal yield increased continuously, reaching a peak of almost 19 mil. tones in the five-year period, from 1976 to 1980, i.e. increasing by 2.3 times (Figure 1). The yield remained at a relatively high level in the next two five-year periods (i.e. 1981-1985 and 1986-1990), when, in Romania, over 18 mil.tones of cereals were produced annually.

Wheat. The evolution of the wheat yield generally followed the same trend as that of cereals, except the fact that the reduction of the cultivated area was slightly more pronounced. The greatest wheat yield was obtained in the five-year plan 1986-1990 (Figure 1).

Maize. It is the breed with the largest cultivated land area in Romania, rivaling that of wheat and barley together. In normal years, the yield is also more than half of that obtained from all the other cereals together. The area cultivated during the command economy was the highest in the 1956-1960 five-year plan (3,613 thousand ha). The annual average for the maize yield exceeded 10 million tones for the period 1976-1985; however, in the last years of the command economy, it decreased significantly (Figure 1).The territorial profile of the Romanian agriculture shows that the wheat and the maize have always strived for primacy, depending on the environmental favorability. On a descending scale of the environmental favorability on counties, the wheat may extend between 1,700 and 2,000 thousand ha, while the maize is restricted from maximum 3,400 thousand ha to 3,100 thousand ha minimum.

The evolution of the average yields, although positive, reflects a lag compared to most EU countries (Figure 2), the difference increasing from one period to another. In Romania, an extensive agriculture was practiced even during the command economy, when the statistics and the volume of the material costs showed some intensity in the allocation of inputs (irrigation, fertilizers, advanced biological material).

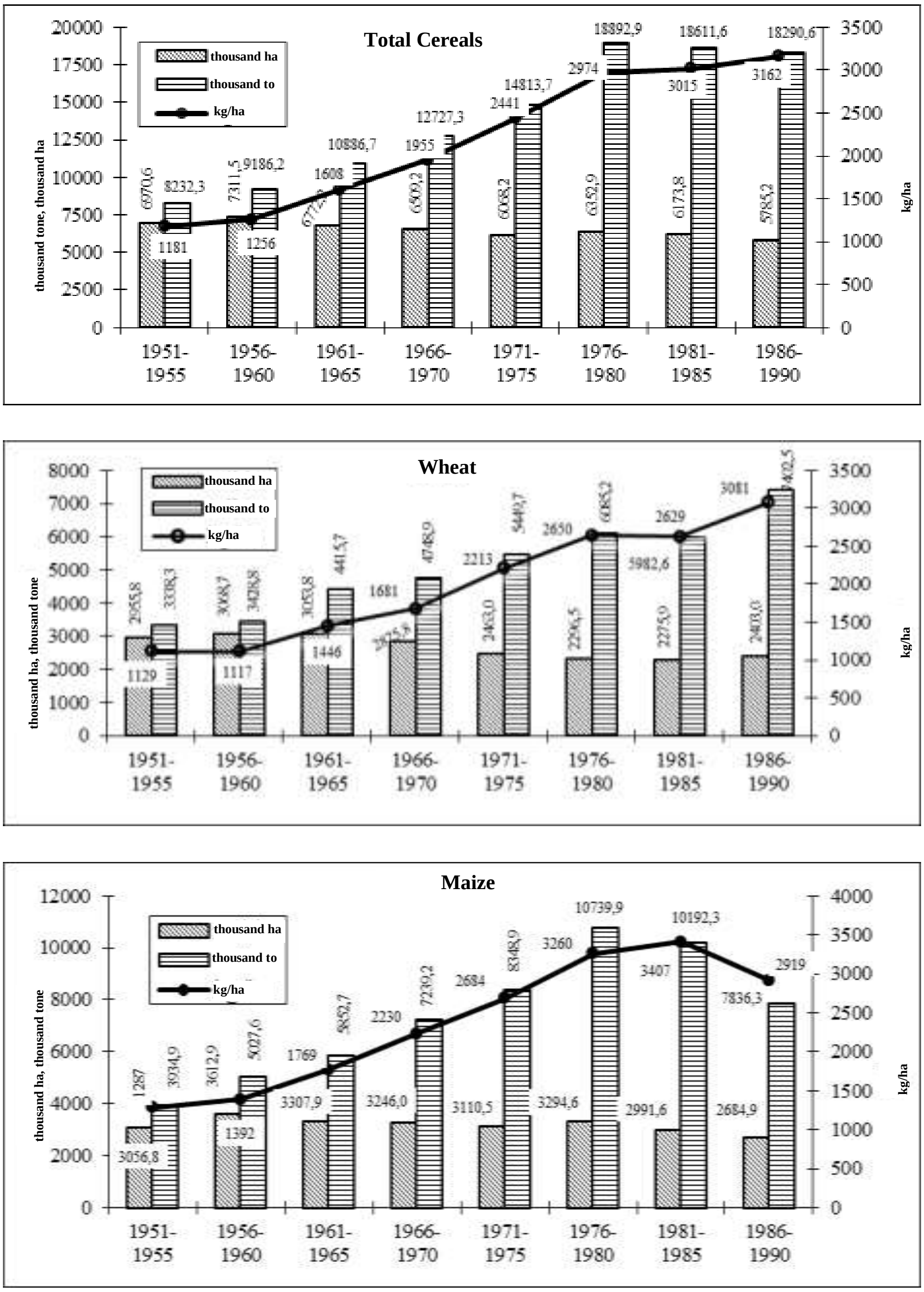

Fig. 1. The evolution of areas, for the total and average yield in cereals, wheat and maize, in Romania, during 1951-1990

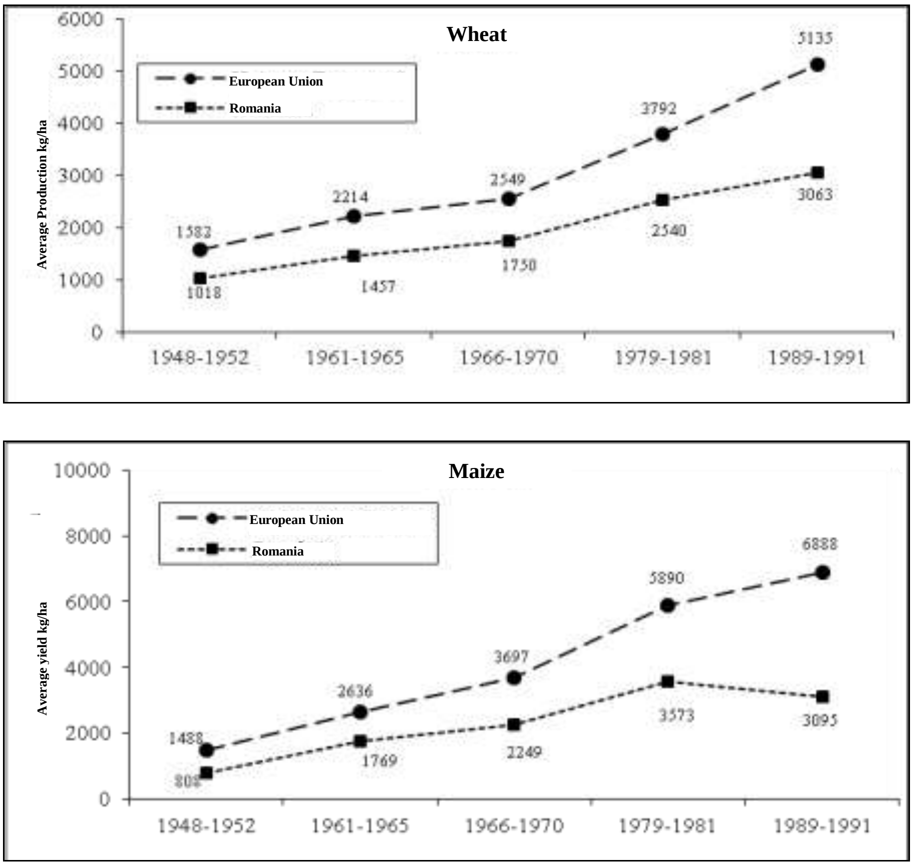

Fig. 2. The evolution of the average yield per ha in wheat and maize, in EU-15 and in Romania, during 1948-1991

Serious technological impediments in the quality of work, the failure to comply with the optimal periods for the execution of works, failure to comply with the irrigation regime, the waste and the poor plant protection largely tithed the yield capacity of Romanian breeds and hybrids.

2. The oilseed plants

They belong to the most comprehensive group of non-food crops. From a botanical perspective, the oilseeds belong to very different families, their aggregation criterion being the one represented by their final product, i.e. the oil. Of these, the most important ones, which are grown in *pure culture*, are the sunflower, the soybean, the rapeseed, followed by the flax, the castor oil plant and by other plants cultivated on much smaller areas. The entire group of oilseeds was cultivated on increasingly larger areas, from 447.1 thousand ha, during 1951-1955, peaking, in 1986-1990 five-year plan, to 910.5 thousand ha, and to an average yield of 1,165 kg/ha (Figure 3).

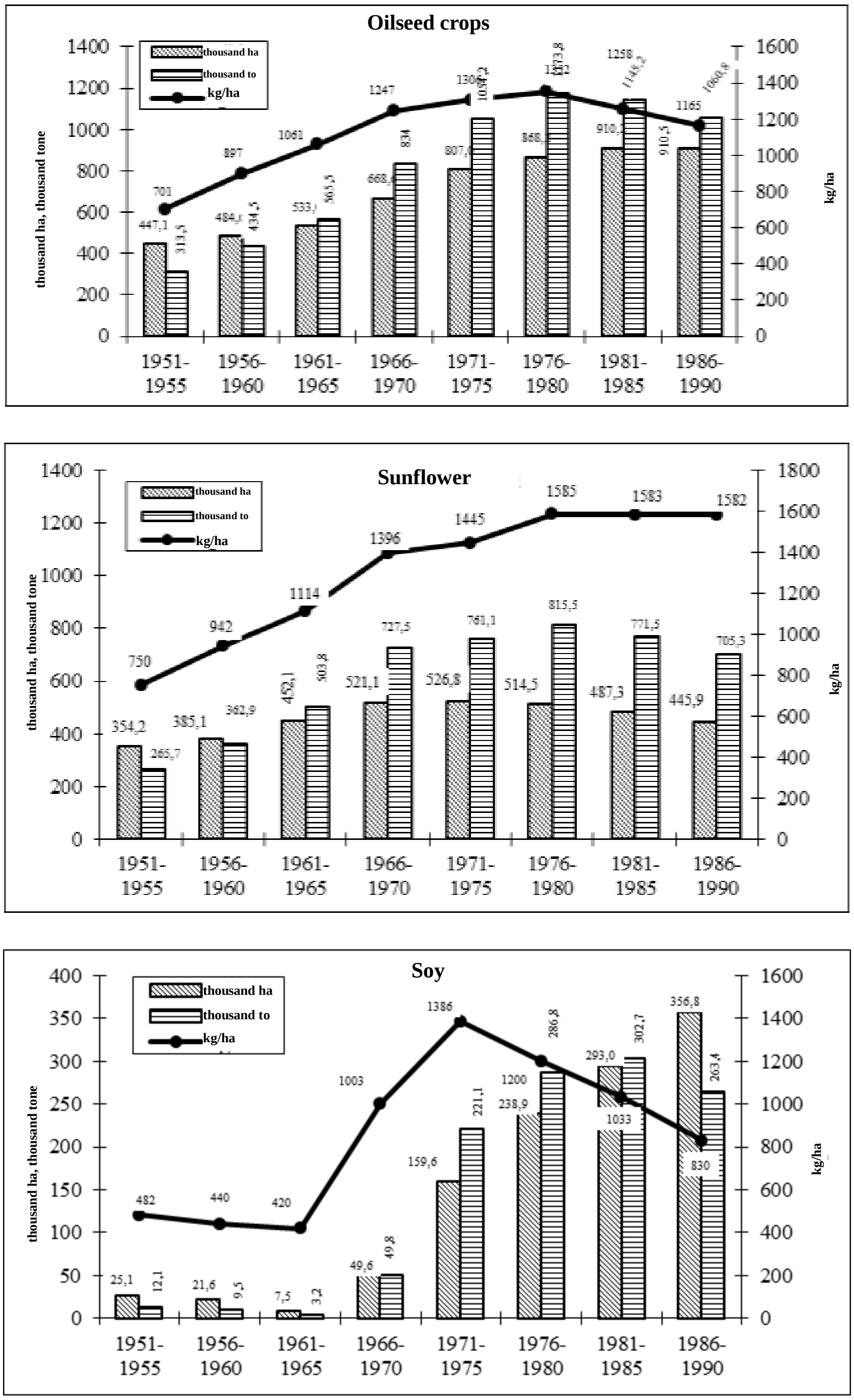

Fig. 3.The evolution of the cultivated land areas and of the yields of oilseed crops, sunflower and soy in Romania (1951-1990)

Sunflower. In the period before the war, the statistics reported, for the years 1925-1929, a cultivated land area of 128 thousand ha and a yield of 740 kg/ha. In the early years after the war (1945-1947), the cultivated land area increased to about 400 thousand ha but the average yield reduced to just 390 kg/ha (Figure 3). During the socialist agriculture, the sunflower was grown on areas increasingly larger, from 354.2 thousand ha and an average yield of 750 kg/ha, during 1951-1955, and reaching a maximum of 487.3 thousand ha and 1,583 kg/ha in the five year plan 1981-1985 (Figure 3).

Soybean. It was cultivated on small areas, with modest yields until the early 70's, when the first large irrigation systems were brought into service. In the years 1971-1975, the soybean was cultivated on almost 160 thousand ha, and the highest average yield, i.e. 1,386 kg/ha, was obtained. The cultivated land area was further expanded to over 350 thousands ha. However, because of the inadequate technology, the average yield reduced to less than 900 kg/ha (Figure 3).

3. Sugar beet and potatoes

Sugar beet. It was grown on areas between 100-200 thousand ha, until the early 70's, in the traditional areas of Transylvania, Maramures, northern Moldavia. Afterwards, it was extended in the areas equipped for irrigation from the south and the east of the country, reaching, in last years, to over 300 thousand ha (Figure 4). The territorial self-sufficiency program launched in the last years of the regime included the establishment of over 30 sugar mills, which had to be supplied with raw material. The sugar beet was grown exclusively by agricultural cooperatives until the last year, i.e. 1989, when it was also imposed to state agricultural enterprises, because of yields per ha, which were some of the lowest in Europe, even after it had been located in the southern and south-eastern parts of the country, on exclusively irrigated land. On average, for the years 1977-1978, Romania achieved 23,352 kg/ha, Bulgaria 25,641 kg/ha, German Democratic Republic 29,122 kg/ha, Hungary 35,246 kg/ha, France 44,050 kg/ha and the Federal Republic of Germany 47,512 kg/ha (Parpală, 1980).Even in the last years of planned economy, the average yields were wholly unsatisfactory, given the many technological deficiencies, the faulty irrigation and the mechanized harvesting losses being the most important. On average, for the period 1986-1989, only 21,800 kg/ha roots were obtained, while, during the same period, France obtained 65,593 kg/ha, more than three times (FAO Yearbooks - Yield).

Potatoes. Although basic components of the food system, the human consumption did not exceed 2,000 tones during the whole period. The industrial needs and the use in animal feeding led to a continuous increase in the potato yield, which was mostly satisfied by expanding the cultivated land areas from 247.5 thousand ha, in the period 1951-1955, to almost 332 thousand ha, in the period 1986-1990 (Figure 4).

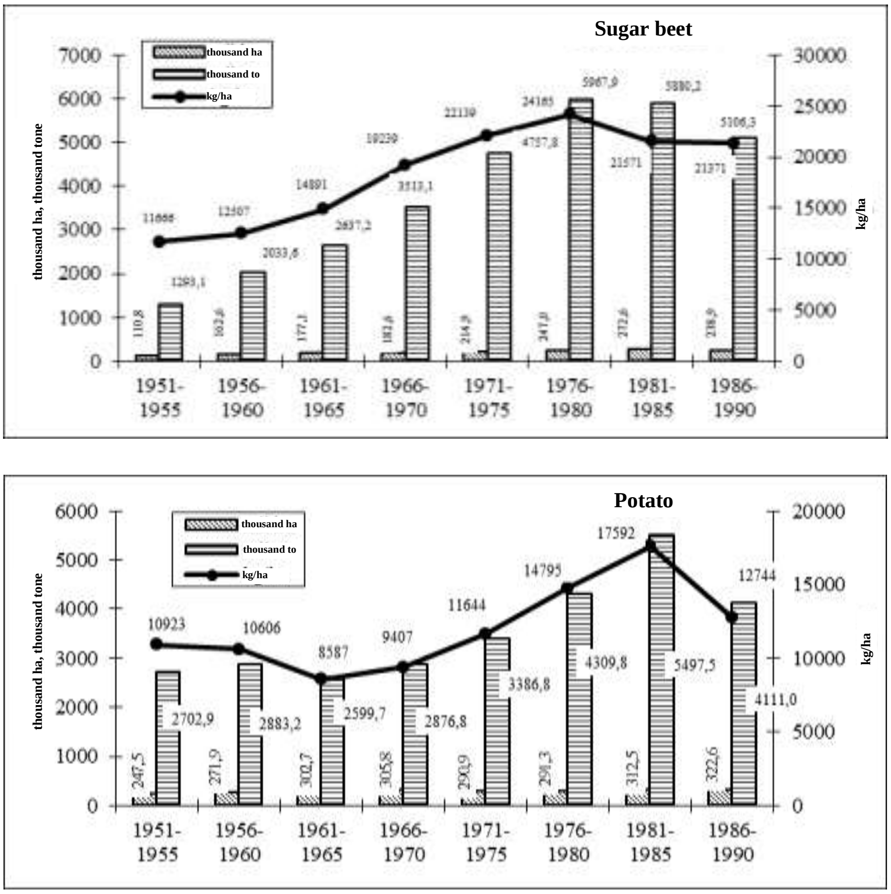

Fig. 4. The evolution of the cultivated land areas and of the yields obtained in sugar beet and potato, in Romania, during 1951-1990

The increase in the potato cultivated land area was necessary because of the low yields per ha, i.e. nearly 11 t/ha during 1951-1955, and 12.7 t/ha in the last years of the regime. In 1978-1980, when Romania obtained 14.4 t/ha, Poland obtained 20.5 t/ha, and the Federal Republic of Germany 29.7 t/ha (Parpală, 1980). On average, for the period 1986-1990, Romania obtained 10.5 t/ha and France 29.8 t/ha, i.e. more than 2.8 times (FAO Yearbooks - Yield).

4. The evolution of the long-term average yield for the main crops, during 1963-1989

By comparing the yield level obtained in the last years of planned agriculture with the one from the beginning of the collectivization and nationalization process of agriculture from 1951-1955, it appears that the latter period appears favorable and it is normal to be so. The war years, the catastrophic drought of 1945-1946, the nationalization process, the relentless struggle against the kulaks, i.e. precisely against the most performant farmers of that time, decisively affected the yields per ha.On a long term, the yield per ha recorded the highest increases in cereals, i.e. wheat, maize and barley, and, as far as the non-food crops are concerned, in sunflower (tab.2)

Table 2. The yields for the main crops during 1951-1955, compared to 1986-1989 q/ha

Period	Wheat	Maize	Barley	Rice	Beans	Peas	Hemp bundle	Sunflowe r	Potatoes	Sugar beet	Tobacco	Hemp	Cabbage
1951-1955	11,2	12,7	10,5	25,5	5,2	8,6	24,3	7,4	98	117	6,45	84	174
1986-1989	30,6	29,4	38,8	25,6	6,7	10,6	33,4	16,2	137	216	9,3	107	211
1986-1989 / 1951-1955 %	272	232	369	100	131	123	137	218	140	18/5	145	127	121

Source: Processing based on the Romanian Statistical Yearbooks.

The major differences between the two periods are explained primarily by the outstanding level of the average yield in the first period, i.e. 11.2 q/ha for wheat, 12.7 q/ha for maize or 10.5 q/ha for barley. Compared to this level, in the last years of planned economy, the average yields were more than 2.7 times higher for wheat, about 2.3 times higher for maize and nearly 3.7 times higher for barley.

Significantly higher yields were obtained from sunflower, as it was less dependent on irrigation; however, in this respect, a significant contribution was brought by the shift from breeds to more productive hybrids, as in the case of maize. Small yield increases have been achieved in grain legumes and textile plants, breeds which had been neglected during most of the planned economy.

A special case is represented by high intensity crops, such as the sugar beet or the potato, which, in the last years, were cultivated solely on areas equipped for irrigation but not irrigated, which, along with other technological malfunctions, explain the unsatisfactory results obtained.

5. The evolution of the average yield in some crops in the socialist agricultural system

In the spring of 1962, the agricultural cooperativization process ended, so that, starting with the next year, the agriculture developed and performed exclusively under the socialist system, represented by the two kinds of agricultural holdings: state agricultural enterprises (known as IAS in Romanian) and agricultural cooperatives (known as CAP in Romanian).

During this period, the Romanian agriculture underwent an intense modernization process, the number of tractors increasing from 57,500 units to 151,7 thousand units, i.e. over 2.6 times. The amount of fertilizer delivered to agriculture increased from 101.8 thousand tons to 1,158.8 thousand tons, i.e. over 11 times, and the area equipped for irrigation increased from about 200 thousand ha to more than three million ha, i.e. 15 times. The biological material was greatly improved, as well as the technological system as a whole, and it also generally benefited from specialized management.The evolution of the series adjusted to the socialist agriculture period 1963-1989 is shown in fig. 5-10.

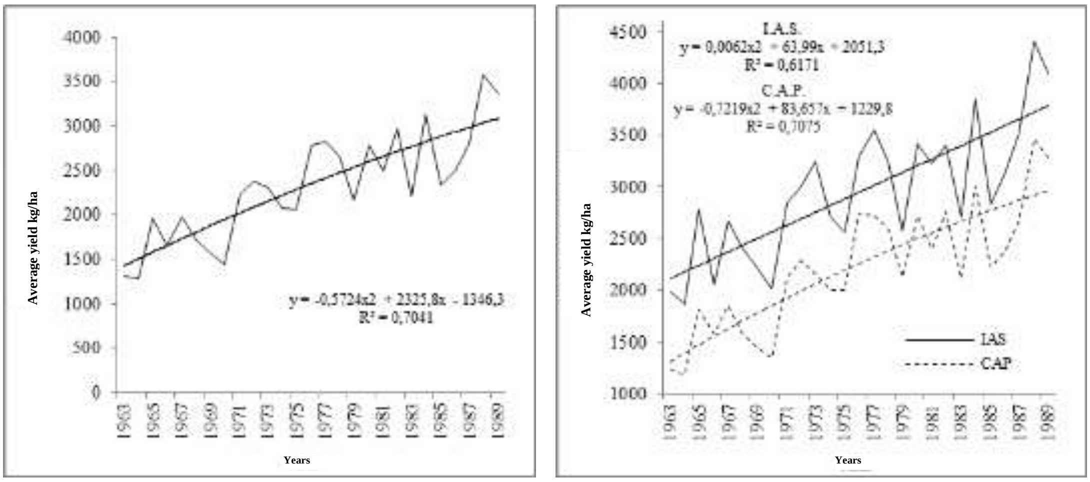

Fig. 5. The evolution of the average yields in wheat, in Romania, per total agriculture, in IAS and CAP (1963-1989)

Except for wheat, where the developments of the average yields per ha increased until the end of the period, in the other crops, i.e. maize, sunflower, soybean, sugar beet and potato, there is recorded a yield peak placed somewhere (depending on the crop) between 1975-1985; however, in last years, the yields decreased significantly.

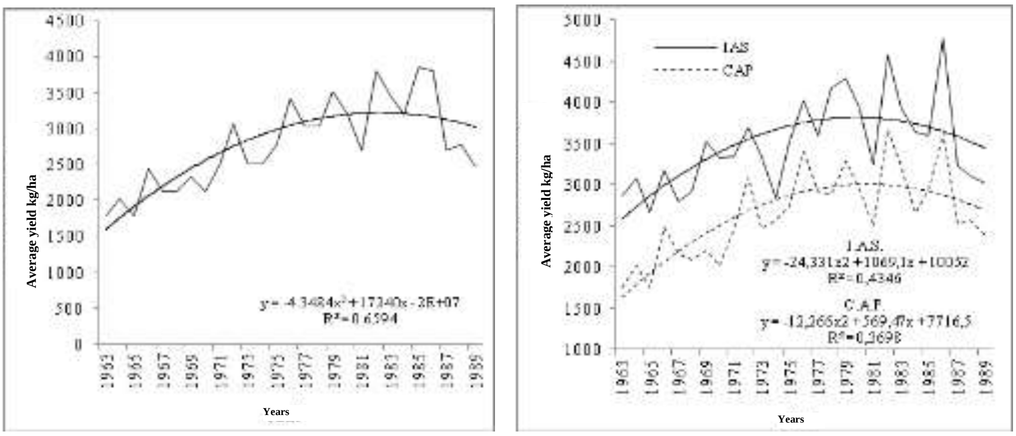

Fig. 6. The evolution of the average yields in maize, in Romania, per total agriculture, in IAS and CAP (1963-1989)

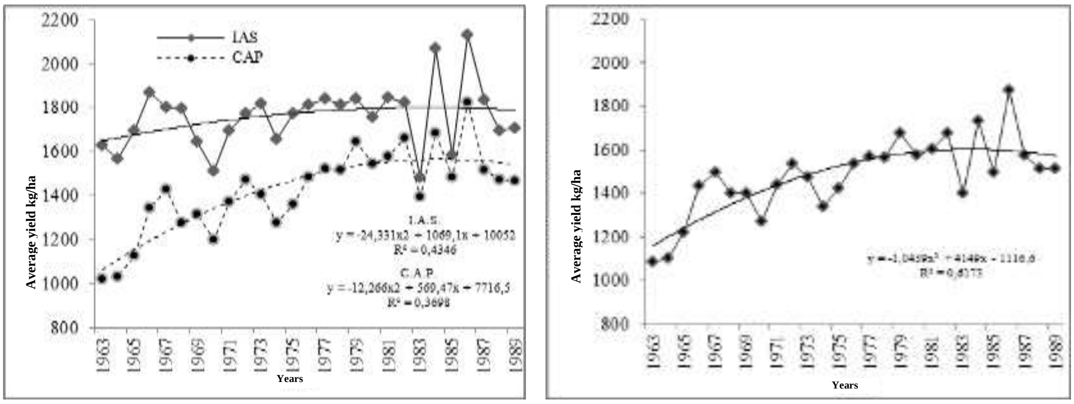

Fig. 7. The evolution of the average yields in sunflower, in Romania, per total agriculture, in IAS and CAP (1963-1989)

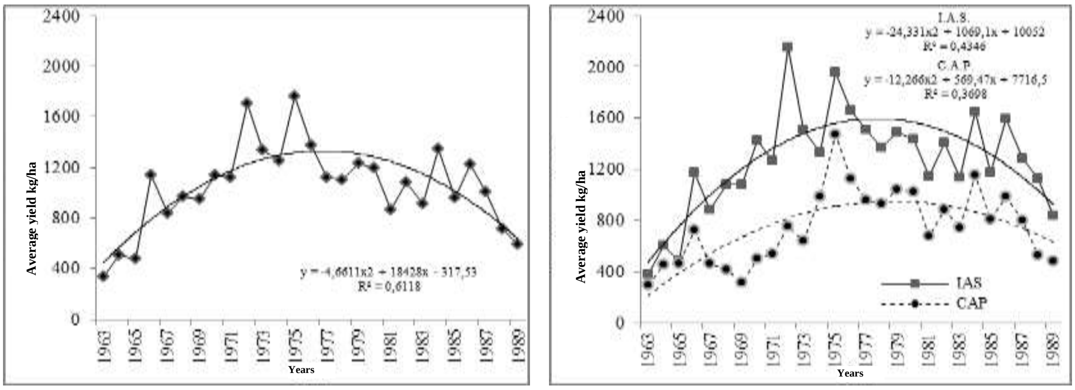

Fig. 8. The evolution of the average yields in soybean, in Romania, per total agriculture, in IAS and CAP (1963-1989)

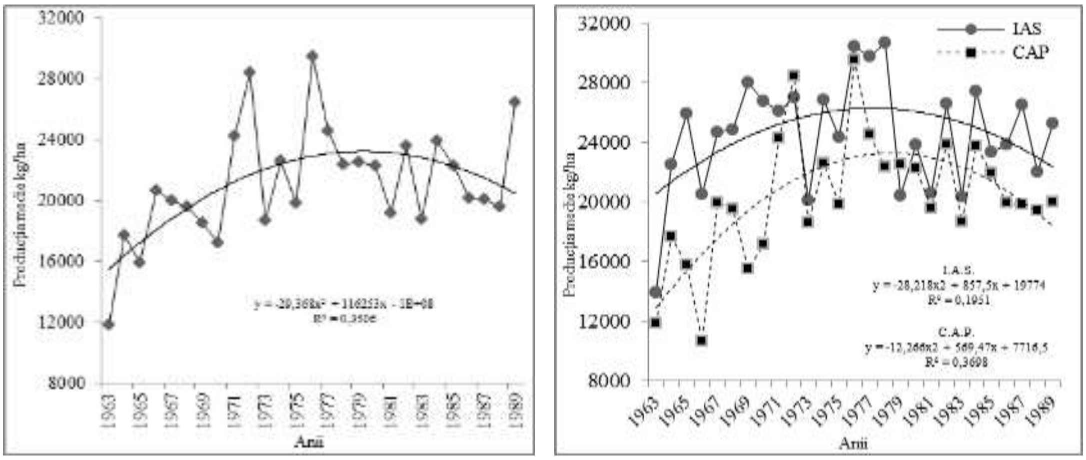

Fig. 9. The evolution of the average yields in sugar beet, in Romania, per total agriculture, in IAS and CAP (1963-1989)

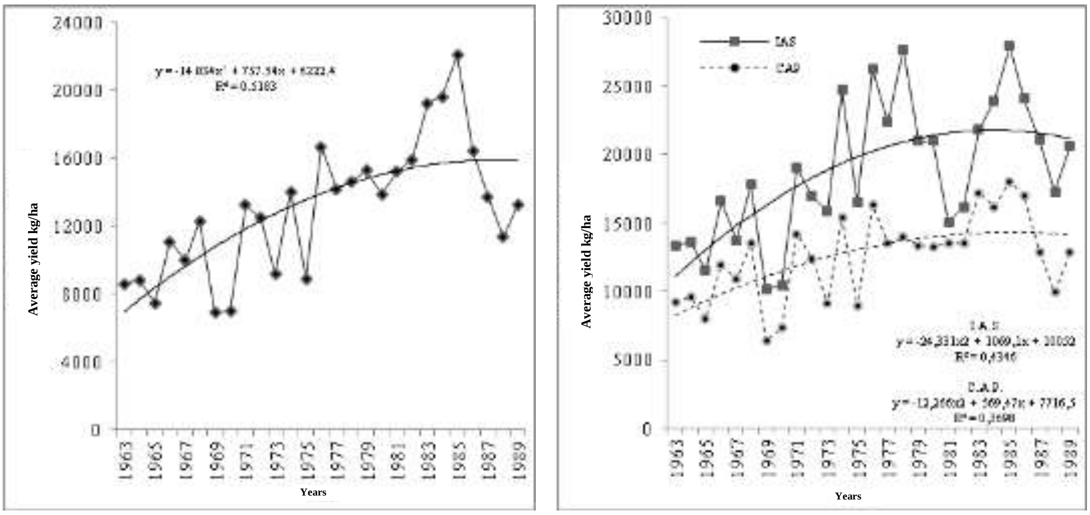

Fig. 10. The evolution of the average yields in potatoes, in Romania, per total agriculture, in IAS and CAP (1963-1989)

The technological degradation in all its aspects - including the irrigation regime - are responsible for this development. There is also a significant difference between the state agricultural enterprises - state agricultural holdings - and the agricultural cooperatives, the latter's average yield level being significantly lower.

CONCLUSIONS

1. The period after the Second World War meant, for the Romanian agriculture, the transition from an ancestral and primitive technological system to a modern

agriculture, in many ways comparable to that of the developed economies from Western Europe and North America.

2. The agricultural technological revolution was triggered by the political regime established in 1945, which aimed, among others, at the economic and agricultural modernization and at the increase of its technical and economic competitiveness.
3. It has been invested heavily in both capitalization, i.e. tractors and working equipment, ample land reclamation works, and in increasing the provision of inputs: fertilizers, performant biologic material, pesticides, water.
4. The result of this technological revolution and management translated into significant increases of yields per unit area, at the main crops. Lately, however, the state economy did not succeed in maintaining a technologically advanced system so that the average yield was in decline.
5. Despite all its recorded performances, the socialist agricultural system remained considerably behind the market economy states.

BIBLIOGRAPHY

1. Lup A.: Introducere în economia şi politica agrară. Ed. Ex Ponto, Constanţa, 2007.
2. Parpală O.: *Economia şi politica agrară a R.S.R.* Ed. Didactică şi Pedologică, Bucureşti, 1980.
3. x x x: *Agricultura României 1938-1990.* Ed. Tehnică Agricolă, Bucureşti, 1992.
4. x x x : *Anuarele statistice ale României.*
5. x x x : *Anuarele FAO*

Annals of the Academy of Romanian Scientists
Series on Agriculture, Silviculture and Veterinary Medicine Sciences
Online ISSN 2069 – 1149 Volume 4, Number 1-2/2015

REVIEW REGARDING THE IDENTIFICATION OF VEGETABLES WITH HIGH QUANTITIES NITRATES IN ROMANIA

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Abstract: *By eating plants or drinking water containing high contents of nitrates or nitrites, the nitrogen enters in the body, it combines with hemoglobin, resulting in a stable compound methemoglobin, so that the bodies present specific phenomenon anemia. Nitrates and nitrites are used as preservatives in the food industry; in such corned nitrosamines were identified health risk to consumers. To reduce the concentration of residual nitrites in meat products it was questioned the use of vegetables as natural sources of nitrite and bring added value to the food. The paper presents the research of our country on nitrate and nitrite content, nutritional value, agro cultivars used and methods used in the culture of vegetables in our country. Since the nitrates and nitrites are found mostly in vegetables that consume leaves and plant parts it finds more raw sap (root, leaf petiole, language) shows a group of vegetables valued as containing average content or high nitrates and nitrites.*

Keywords: Methemoglobin, natural preservatives,, nitrates, nitrites.

1. Introduction

One of the plant nutrients is nitrogen. It is found in soil organic matter (humus or organic waste) or mineral compounds (nitrates, nitrites, ammonia etc.)

Administered in the form of chemical or organic fertilizers contribute to increased production, but can be leached, reaching groundwater or driven by water currents above the ground, can be reached water in lakes and rivers, polluting them. When it is accumulated in large quantities it is accumulated in plants. By eating plants or water consume which containing high quantities of nitrates and nitrites, enters on the human body, it combines with hemoglobin results methemoglobin. In contrast to hemoglobin, which is combined with oxygen in the lung, which then gives it tissues, methemoglobin is a stable compound; as a result, part of the hemoglobin is converted to methemoglobin and bodies presented specific phenomena anemia - sometimes very serious - that may increase mortality of young bodies - children and animals. [20].

Nitrates toxic action on man shows when consuming more than 200-300 mg. N as NO_3 on 100 g dry for 24 ore. Fertilization with nitrates - decrease Mo in plant content. (Fritz et al, cited by Lixandru Gh., [11]. Literature cites the case of people

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living on a lake in North America, lake polluted by nitrogen from agricultural land nearby. Fertilizers where nitrogen is applied once the crop over the required dose. Residents drank water from the lake and as a result, infant death increased from 2 ‰ to 5 ‰. When fertilizers were applied fractionated, then infant mortality fell within the area. [7].

As noted previously, nitrate and nitrite content of plants depends on the amount of nitrogen in the soil. Research conducted by Alexandrina Vasu [21] found 20-30 % of hemoglobin of lactating dairy cows blocked as methemoglobin when on fertile soils were applied high nitrogen fertilizer doses. Thus, although there were obtained high yields of forage, they nitrate content and livestock production was affected.

Under the *law tolerance*, any vegetation factor in terms of quantity / intensity shows a minimum (an area where there is deficiency), then an optimum and, when the amount / intensity continues to increase, it becomes toxic and then became lethal. In what concerns nitrogen, optimum plant does not correspond to the optimum for the consumer, because the content of nitrates and nitrites in plant can be toxic to the consumer. It must therefore know at what level (at which point) of the curve tolerance is achieved acceptable concentration for the consumer. So it must know the content of nitrogen in the soil.

Total nitrogen content in the soil concerned agronomy specialists since the nineteenth century. This content is the content of humus and mineralization conditions. humus content and total nitrogen in the main soil types in our country are shown in Table 1.

Table 1. Humus content and total nitrogen of the main soil types in our country after Ionescu-Şişeşti Gh., Staicu Ir., [10]

Soil Type	Humus content in soil (%)	Total nitrogen content from soil (%)
Sol-brown steppe	2-4	0,190
Brown Chernozem	3-5	0,210
Chernozem chocolate	5-7	0,230
Chernozem	6-8	0,278
Chernozem degraded (leachate)	5-7	0,290
Reddish-brown soil Forest	2-4	0,162
Podsol from Gaesti	2-3	0,118

Plants accumulate different nitrate (NO_3), plant tissue accumulation is dependent on genetic factors, environment (humidity, temperature, radiation, light exposure period) and agricultural (dose and chemical form of nitrogen compounds using, summer use of herbicides). [12]

By appropriate agro-technical measures can increase soil nitrogen content, can raise all kinds of soil fertility. This is the case in vegetable growing, where large amounts of fertilizer are used, both organic and mineral, so the probability that plants have a high content of nitrate is increased.

Growing conditions also intervene in this sense in greenhouses and solariums amount of manure administered reach 80-100 t / ha, while in field is 40-45 t / ha. Following lettuce grown in greenhouses has a higher content of nitrates compared to the cultivated field. [6, 13]

Nitrates and nitrites are used as preservatives in the food industry because: 1) release nitric oxide (NO) with myoglobin forms nitrozmioglobina, offering meat and meat products pink color, very appreciated by consumers; 2) controls the oxidation of lipids; 3) antimicrobial effect; 4) enhance the flavor of meat and meat products.

The use of nitrates for preserving meat is more limited because they are stable and the release of NO is produced by fermentation processes. Reduction of nitrate to nitrite under the action of the natural enzymes present in meat or under the action of the bacteria that possess nitrate reductase, added later in the flesh [9, 16]. Currently, the use of starter cultures possess nitrate reductase is the most common method of preserving meat products, nitrite, nitrate and not being true conservation ingredient.

Since 1971 nitrites in cured meat nitrosamines were identified health risk to consumers. Nitrosamines compounds, potentially carcinogenic, are formed under specific conditions of pH and temperature, from the reaction of secondary amines with nitrite ion. If there corned sufficiently high concentrations of residual nitrite cooked at t> 130ºC, the probability that there are nitrosamines is higher. [19]. For this reason, researchers have put the issue of reducing the concentration of residual nitrites in meat products by using natural sources of nitrite provide, by their composition a higher value to food.

Thus, to avoid the consumption of nitrate and nitrite in dangerous quantities for human health by Order No.1 / 2002 of the Ministry of Health regarding food safety [23], were established maximum limits for nitrates allowed in some fresh fruit and vegetables for marketing and human consumption. (Table 2).

Table 2. Maximum levels of nitrates allowed in some fresh fruit and vegetables for marketing and human consumption. (mg NO_3 / kg fresh product). [23].

Product	**Cultivated in**	
	Field	Greenhouse
Peppers (bell peppers, green peppers, kapia, hot)	150	400
Potatoes	300	-
Cucumbers	200	400
Dehydrated onion	80	-
Cauliflower	400	400
Courgettes	500	-
Carrots	400	-

Lettuce	2.000	3.000
Red beets	2.000	-
Spinach	2.000	3.000
Tomatoes	150	300
Cabbage	900	-
Eggplant	300	400
Apples	60	-
Pears	60	-
Watermelon red	100	-
Grapes	60	-

Table 3 shows the nitrate content of several basic production vegetable plants.

Table 3. The content of nitrates in the basic production (mg / kg crude – grass product, unprocessed) [22]

High (up to 5000)	**Medium (300-600)**	**Low (80-100)**
Lovage (*Levisticum*)	Cauliflower	Brussels sprouts
Cress (*Lepidium sativum*)	Courgettes	Garden peas
Lettuce *(Lactuca sativa ssp. capitata)*	Pumpkin	Beans
Spinach	Japanese radish	Potato
Beet	*Brassica napus var. Napobrassica*	Tomato
Peas	Parsnip	Onion bulbs (*Allium cepa L.*)
Cabbage *(Brassica oleracea* var. *Acephala)*	Horseradish	Melon (*Cucumis melo*)
Green onion	Head cabbage	Watermelons (*Citrulus sp.*)
Radishes	Carrot *(Daucus carota ssp. sativus)*	Berry fruits (boabe)
	Cucumbers	

Generally, the vegetables accumulated large amounts of NO_3. In Romania, the highest NO_3 concentrations were observed in lettuce, spinach, root [12] and tomatoes [17].

The fruits young, very young cucumbers, harvested once formed, green tomatoes and young tissues generally have higher nitrate concentrations [14].

Large quantities of nitrates are found mostly in vegetables that consume leaves (Table 3) and in parts of the plant where the raw sap finds much (root, leaf, petiole and limb). [22].

2. Material and method

To identify the potential of nitrate and nitrite accumulation in vegetables grown in greenhouse, solarium or field in Romania, there were used dates from the literature of our country during about ten years. [1, 2, 3, 4, 8, 14]

3. Results and Discussion

Chirică Barbu Mileva et al. [4] monitored the quality characteristics of some cultivars of tomato products in solarium and greenhouses supplying markets in Bucharest. Table 4 presents some results of analyzes performed.

Table 4. Analysis of nitrates, phosphorus and potassium in tomato fruits harvested at three periods. Averages on the cultivar [4].

	Culture	Cultivar	$N\text{-}NO_3$ ppm	$P\text{-}PO_4$ ppm	K, ppm
The first measurement - The beginning of harvest (20 May 2012)					
1	Solarium	Siriana F1	146.7	156.3	973
2	Solarium	Arletta F1	138.3	175.8	086
3.	Greenhouse	Siriana F1	144.3	170.2	1008
4.	Greenhouse	Katerina F1	145.2	165.3	1102
A second determination - Maximum harvest (05.June.2012)					
1	Solarium	Siriana F1	128.2	196.5	1950
2	Solarium	Arletta F1	104.0	198.7	1870
3	Greenhouse	Siriana F1	109.3	200.1	1960
4	Greenhouse	Katerina F1	119.3	189.3	1890
A third determination - End of harvest (15.June.2012)					
1	Solarium	Siriana F1	98.3	220.4	1489
2	Solarium	Arletta F1	100.7	210.5	1503
3	Greenhouse	Siriana F1	87.6	219.3	1574
4	Greenhouse	Katerina F1	101.3	215.3	1687
Maximum permissible limits according to the literature			**C.M.A. – 300 ppm**	**200-400 ppm**	**1000-2000 ppm**

It is noted that the nitrates decreased quantify which is attributed to the appropriate fertilization and metabolism of this compound during the ripping.

Phosphates increase during the process, and potassium content increased to the second measurement, and then lowers, while remaining at values higher than initial period.

Soluble carbohydrate content (%), vitamin C (fresh produce), lycopene (ppm) and carotene (fresh produce) is presented in Table 5.

Table 5. The content of soluble carbohydrates, vitamin C, lycopene and carotene in tomato fruits grown in greenhouses and solariums. [4]

Culture	Cultivar	Soluble carbohydrates %	Vitamin C mg/100 g f.p.	Carotene f.p.	Licopene (ppm)
Greenhouse	Katerina F1	4.79	15.2	8.24	24.98
Greenhouse	Siriana F1	4.78	12.8	7.95	22.37
Solarium	Arletta F1	4.81	12.4	7.52	13.00
Solarium	Siriana F1	4.58	14.2	8.12	10.92

These data indicate the nutritional value of tomatoes, showing that these vegetables as sources of nitrate are also a source of nutrients and vitamins.

Tables 4 and 5 shows the variability of the content of mineral elements, carbohydrates, vitamins and provitamins, depending on the cultivar.

Neaţă Gabriela et al., [14] analyzing some vegetables from the markets of Romania, found quantities of nitrates and nitrites which are shown in Table 6.

Table 6. Contents of nitrate and nitrite in some vegetables from the markets of Romania [14]

No.	Product	ppm NO_3^-	M.A.L. NO_3^-	ppm NO_2^-	M.A.L. NO_2^-
1.	Lettuce cultivar iceberg *	1878+/-79	3000	0.12+/-0.02	0.5
2	Lettuce cultivar Mona *	1567+/-56	3.000	0.18 +/-0.08	0.5
3	Lettuce cultivar Marula **	789+/-92	2.000	0.23 +/-0.07	0.5
4	Tomatoes Amanda*	267+/-13	300	0.12 +/-0.05	0.5
5	Tomatoes Tovi Roca*	195+/-14	300	0.21 +/-0.06	0.5
6	Tomatoes Lady Rosa*	258+/-15	300	0.18+/-0.06	0.5
7	Tomatoes Menhir*	289+/-15	300	0.23 +/-0.04	0.5
8	Tomatoes Siriana F1 **	98+/-17	150	0.19 +/-0.06	0.5
9	Tomatoes Arletta F1**	112+/-19	150	0.22 0.08	0.5
10	Carrots De Nantes	323 +/- 7	400	0.25+/- 0.10	0.5
11	Carrots Narbonne	253+/-12	400	0.26+/-0.08	0.5

* Culture in the solarium or in green house ** Culture in field

It is noted that all species that have been made analysis containing both nitrates and nitrites. In field crops, nitrate and nitrite content is generally low.

Biochemical characteristics of tomato paste, juice and other products marketed in some European countries are shown in Table 7.

Table 7. Biochemical characteristics of tomato paste, juice and other products sold in our country [8]

Variant	Carbohydrates **%**	% Acidity	% Vitamin C, mg / 100 g fresh weight	Lycopene mg / 100 g fresh weight
Ketchup, Bulgaria	4.2	0.6	37.25	166.4
Pizza juice, Italy	4.8	0.5	43.25	328.7
Spaghetti juice, Romania	3.9	0.7	45.13	175.4
Tomato pasta (Olimpia), 3 %	4.5	0.5	36.89	345.2
Tomato pasta (Sultan), 24 %	4.3	0.6	32.45	287.3
Pomodore for pizza	4.3	0.6	44.56	214.5
Pasta Maxim 22-24 %	4.7	0.7	50.25	214.7
Tomato juice, Romania	4.2	0.5	43.12	78.3
Peeled tomato	4.2	0.8	52.14	89.3

Table 8. Chemical characteristics of tomato paste, juice and other products sold in our country [7]

Variant	**pH**	**$N\text{-}NO_3^-$ ppm**	**P ppm**	**K ppm**	**Ca ppm**	**Mg ppm**	**Na ppm**
Ketchup, Bulgaria	4.2	60.7	86.5	1970	168.4	213.7	70.2
Pizza juice Italy	4.2	58.9	80.7	2110	176.5	243.5	67.5
Spaghetti juice Romania	4.0	60.2	98.7	2450	210.2	324.5	68.2
Tomato pasta (Olimpia), 33%	3.9	142.0	1631.0	10400	1234.5	634.2	124.7
Tomato pasta (Sultan), 24 %	3.7	115.9	1767.0	22400	1154.8	598.3	146.7
Pomodore for pizza	4.0	102.6	95.7	4200	978.4	367.2	79.2
Pasta Maxim 22-24 %	3.9	95.0	1942	9000	1067.8	432.6	116.8
Tomato juice, Romania	4.2	56.9	98.7	2740	123.7	256.9	65.3
Peeled tomato	4.1	95.6	115.34	134.5	134.5	267.5	70.4

From the tables 7 and 8 apparent high nutritional value of tomato products from industrialization of tomatoes and also presents nitrates $N\text{-}NO_3$ contents.

Research conducted on the quality of carrot cultivars used in Dobrogea, [1] refers to the agrochemical characteristics as well as biochemical and yields obtained. Table 9 presents agrochemical characteristics and Table 10 - biochemical characteristics.

Table 9. Agrochemical Characteristics of some cultivars of carrot used in Dobrogea [1]

Variant	Cultivar	Content ppm		
		$N\text{-}NO_3^-$	$P\text{-}PO_4$	K
Ct	De Nantes	78	268.31	2450
V1	Belgrad F1	76	318.32	2980
V2	Marion F1	101	298.50	2540
V3	Canada F1	95	246.21	2380
V4	Florida F1	98	265.10	235

Table 10. Biochemical Characteristics of carrot cultivars used in Dobrogea [1]

Variant	Cultivar	Carbo-hydrates %	% Acidity	% Vitamin C, mg / 100 g fresh weight (malic acide)	Carotene mg / 100 g fresh weight
Ct	De Nantes	5.8	0.46	185	8.50
V1	Belgrad F1	5.9	0.52	293	7.20
V2	Marion F1	6.2	0.65	250	9.12
V3	Canada F 1	8.2	0.57	199	10.60
V4	Florida F1	7.1	0.61	260	9.80

Table 11. The yields of carrot cultivars used in Dobrogea [1].

Variant	Cultivar	Yield t/ha	Procent	Dif. +/-	Signification
Ct	De Nantes	17.6184	100.00	-	-
V1	Belgrad F1	17.7704	100.86	+ 0.152	ns
V2	Marion F1	16.2592	92.28	- 0.0892	0
V3	Canada F1	18.1888	103.34	+ 0.5704	ns
V4	Florida F1	17.9824	102.06	+0.364	ns

From Tables 9, 10 and 11 there is a nitrate content below the limits set out in Ord. No. 1 of 3 January 2002.

Research on biological culture of carrots was the subject of Câmpeanu Gh. et al. [3]. The result carrots quality analyzes presented in Tables 12 and 13.

Table 12. Nutrient content of carrots in unchanged form. [3]

Variant	N-NO_3^- Ppm	P-PO_4 ppm	K ppm
Crop growing stage intermediate (carrots the size of a pencil)– 08.June.2012-			
Ct	115	64.4	2020
1. 4 kg. cattle manure / m^2	117	108.0	2300
2. 6 cattle manure / m^2	151	110.0	2220
3. 8 cattle manure / m^2	126	92.8	2140
4. 2 kg. chicken manure / m^2	154	96.8	1860
5. 3 kg. chicken manure / m^2	158	71.2	2060
6. 4 kg, chicken manure / m^2	174	64.8	2100
Final harvest – 13.97.3012			
Ct	141	313.6	2340
1. 4 kg. cattle manure / m^2	107	385.2	2980
2. 6 cattle manure / m^2	167	387.6	3440
3. 8 cattle manure / m^2	187	312.8	2220
4. 2 kg. chicken manure / m^2	183	292.4	2660
5. 3 kg. chicken manure / m^2	166	298.8	1880
6. 4 kg, chicken manure / m^2	308	176.8	1600

From Table 12 shows that the largest amounts of N-NO_3 variants are fattened with manure from chickens and P-PO_4 and K variants fertilized with cattle manure. These elements are in greater quantities in the final harvest.

Table 13. Biochemical characteristics of final harvesting carrots. [3]

Variant	Sugar %	Vitamin C mg/100 g fresh product	Acidity %
Ct	5,468	0,015	0,1157
1. 4 kg. cattle manure /m^2	5,531	0,0225	0,1447
2. 6 cattle manure / m^2	5,843	0,015	01519
3. 8 cattle manure / m^2	5,593	0,025	0,1302
4. 2 kg. chicken manure / m^2	5,718	0,015	0,1447
5. 3 kg. chicken manure / m^2	5,781	0,0225	0,1302
6. 4 kg, chicken manure / m^2	5,593	0,0225	0,1013

The data in Table 13 indicates a high nutritional value in all variants fattened.

Influence of fertilization system on the quality of cucumbers grown in southern Romania was studied by Gh. Câmpeanu et al. [2]. Variants of the experience are shown in Table 14.

From Table 15, it follows that at cucumbers, the highest content of N-NO_3, P-PO_4 and K variants found in classic variants, especially the cultivar Mirabelle F1. Triumph cultivar F1 evidenced by the high content of K in under the influence of fertigation.

Table 16 highlights the most high carbohydrate and soluble solids in organic fertilization variants, the higher acidity under the influence of classical fertilization and the highest content of vitamin C in fertigation variants.

The conclusions drawn from Table 3 are that nitrates are found in greater quantities in plants that consume the leaves, and plant parts where there is plenty of raw sap (root, leaf petiole and limb), consider we can appreciate vegetables that are medium or high content of nitrates and nitrites.

Table 14: Experimental variants [2].

Variant	Fertilization	Cultivar	Fertilization scheme
11	Organic	*Triumf F1*	20 t/ha manure
12		*Mirabelle F1*	
21	Classic	*Triumf F1*	- Fertilizer Complex: 15-15-15, 250 kg / ha applied to crop establishment. - Two fertilization, 100 kg / ha with the same fertilizer, wide three six weeks after transplanting.
22		*Mirabelle F1*	
31	Fertigation	*Triumf F1* *Mirabelle F1*	- Fertigare S (Starter) - 15 N; 30 P_2O_5; 15 K_2O - with after transplanting to encourage root formation area. - Fertigare I – 14 N; 11 P_2O_5; 25 K_2O – to promote vegetative growth after transplanting on; - Fertigare II – 24 N; 8 P_2O_5; 16 K_2O – to foster enjoyment.
32			

I used vegetable group in [5].

Vegetables from cabbage group:

They have, in general, an average content of nitrates.

-White cabbage, head cabbage *Brassica oleracea L. White*, var.*capitata* L. f. *alba* DC

- Red cabbage *Brassica oleracea var. capitata* L.-f .*rubra* L

- Savoy cabbage, kale, *Br. oleracea* L.,. convar.*capitata* (L.) Alef. var. *sabauda* L.

- Brussels spyouts, Brussels cabbage *Brassica oleracea* L. var *gemmifera* DC

- Kale, scoth kale, curlies, cabbage for leaves *Brassica oleracea* L., convar *acephala* (D.C.) Alef. var. *sabellica* L

- Chinese cabbage *Brassica rapa* l., ssp. *pekinensis* (lour) Hanelt; ssp. *chinensis* (L) Hanelt.

- Cauliflower *Brassica oleracea* L., var. *botrytis* (L.) Miller, subvar. *cauliflora* Alef.

- Broccoli *Brassica oleracea* L., convar. *botrytis* L. var. *cymosa*, *Duchesne* (1875); sin. var. *italica* Plench (1808)

- Kohlrabi, turnip rooted cabbage, kale *Brassica oleracea* L., convar. *caulorapa* (D.C.) Alef., var. *gongylodes* L.

Table 15. Agrochemical characteristics of harvesting cucumbers [2].

Var.	Fertilization	Cultivar	Content. ppm								
			N-NO3			P-PO4			K		
			Min..Max	Medium	%	Min..Max	Medium	%	Min..Max	Medium	%
V_{11}	Organic	Triumf F_1	75..102	87	100.00	146.23...168.12	154.53	100.00	888...932	920	100.00
V_{12}		Mirabelle F_1	88...110	95	100.00	114.56...136.15	124.56	100.00	995...1120	1060	100.00
V21	Classic	Triumf F_1	198...265	252	289.65	162.12....185.54	173.62	112.53	2245...2580	2400	260.86
V22		Mirabelle F_1	185...245	233	245.26	198.23....224.20	214.52	172.22	1996...2170	2060	194.33
V_{31}	Fertirigation	Triumf F_1	140...168	153	175.86	165.12....189.23	173.00	112.17	2010...2156	2100	228.26
V_{32}		Mirabelle F_1	101...119	114	120.00	159.56....225.86	200.13	160.67	1850...2010	1850	174.52

Table 16. Biochemical characteristics of cucumber harvest [2]

Var	Fertilization	Cultivar	Soluble carbohydrates %			Acidity %			Vitamin C, mg ascorbic acid /100g f.p.			Dry matter %		
			Min..Max	Media	%	Min..Max	Media	%	Min..Max	Media	%	Min..Max		%
V_{11}	Organic	Triumf F_1	2.9..3.06	3.05	100.00	0.27...0.32	0.30	100.00	18.55..18.85	18.65	100.00	3.08..3.14	3.12	100.00
V_{12}		Mirabelle F_1	2.89..3.1	3.02	100.00	0.25...0.29	0.28	100.00	18.70..19.15	18.95	100.00	3.16...3.28	3.25	100.00
V21	Classic	Triumf F_1	2.68..2.86	2.78	91.14	0.35..0.42	0.39	130.00	18.07..18.20	18.15	97.32	2.98..3.04	3.01	96.47
V22		Mirabelle F_1	2.75..2.88	2.85	94.37	0.38....0.41	0.40	142.85	18.12..18.45	18.35	184.69	2.92..3.02	2.98	91.69
V_{31}	Fertirigation	Triumf F_1	2.36..2.52	2.48	81.31	0.33...0.37	0.35	116.66	19.55..19.86	19.70	105.63	2.85..2.92	2.85	91.34
V_{32}		Mirabelle F_1	2.26..2.32	2.29	75.82	0.29...0.32	0.31	110.71	19.12..19.35	19.26	101.63	2.70..2.80	2.74	84.30

Varieties underlined that consume leaves, we believe - based on Table 3 - that have a higher content of nitrates;

Root vegetables:

It believes that they have an average content of nitrates.

- Yellow parsnip, carrot *Daucus carota* L. conv. *sativus* (Hoffm.) Hajek
- Parsley, parsley root *Petroselinum crispum* Mill conv. *radicosum* Mill.
- Parsnip *Pastinaca sativa* L. convar. *hortensis* Ehrh.
- Celery, celeriac root - *Apium graveolens* L., convar. *rapaceum* Mill.
- Gardenbeet, beetroot *Beta vulgaris* var**.** *canditiva* Alef. In Table 3, without specifying variety, beets vegetables are included in the group with high content of nitrates.
- Radish *Raphanus sativus* L. convar. *sativus* radish month. In Table 3, radishes month in group vegetables are high in nitrates content.
- Kőrner *Raphanus sativus* L. convar. *Niger* (Mill) - summer and winter radish
- Swede, rutabaga *Brassica napus* var. *napobrassica* L.
- Turnip, edible turnip (syn. Chinese turnips, pears land, stubble turnips, turnip) *Brassica napus,* convar. *rapifera* L. (sin. *B. campestris* L. subsp. *rapifera* Metz. **s**in. *Brassica rapa* L- *esculenta* Coss şi Gam.)
- Sweet patato *Ipomea batatas* Poir.

Bulbous vegetable plants:

- Onion *Allium cepa* L. In Table 3, onion bulbs are included in the group contained with low nitrate and green onions vegetables are included in the group with high content of nitrates.
- Garlic common garlic *Allium sativum* ssp. *vulgare* L.
- Common leek, leeks *Allium Porum* L.

Cucurbit vegetable plants

- Slicing, cucumber pikling, cucumber *Cucumis sativus* L. In Tab.3. – Medium contents of nitrites
- Watermelon *Citrullus vulgaris* L. sin. *C. lanatus* (Thlumb) Mansf. In Table 3 - low content of nitrates
- Gourd, zucchini *Cucurbita pepo* L. convar. *giromoontiina* Greb, sin. var. *Oblonga* Sér.În Table 3 - average content of nitrates.
- Crown gourd, zucchini patison (syn. Bonnet king) *Cucurbita pepo* var.. *patissoniana* GREB sin. *radiata* NOIS.
- Pumpkin, edible pumpkin (syn. Common pumpkin) *Cucurbita maxima* Duch. In Table 3 - Average nitrates content.
- Winter squasb, muscat pumpkin (syn. Pies) *Cucurbita moschata* Duch.

Vegetable herbs

There are plants with high content of nitrates (v. Tab. 2, 3 and 4)

- Cabbge heading lettuce, lettuce *Lactuca sativa* L.
- Endive, chicory *Cichorium endivia* L. ssp. *Endivia*

var. *crispum* - var.

var. *latifolium* Lam. – scarola or garden leaved chicory

- Spinach *Spinacia oleracea* L.
- Orache, mountain spinach, pig weeds *Atriplex hortense* L.
- Ribbed celery *Apium graveolens* L., ssp. *dulce* (Mill.) Lemket Rothm.- ribbed celery; convar. *secalinum* Alef. – smallage, celery leaves
- Swisschard spinach beet, ribbed beet *Beta vulgaris* L., ssp. *vulgaris,* convar. *Vulgaris*-

var. *Flavescens* D.C. var. *vulgaris* – chard leaf

- Cardon,chard *Cynara cardunculus* L.
- Sweet fennel, florence fennel *Foeniculum vulgare* Mill., ssp. *dulce* (Pesl.) Janch., convar. *azoricum* (Mill.) Thell.
- New Zealand spinach *Tetragonia tetrgonoides* (Pallas) O. Kuntz. Sin. *Tetragonia expansa* Murr.
- Basella (sin. Malabar spinach) *Basella rubra* L.
- Cornsalad, hauch, lamb's lettuce (syn. valerianela, field salad, lamb salad) *Valerianella olitoria* Maench., sin. *Vallerianella locusta* L.
- Cooltankard, borage *Borrago officinalis.*

<u>Aromatic and spicy vegetable plants.</u>

The leaves that are consumed are high in nitrates, but given that use small amounts poses no danger to consumers' health. The species that are consumed seeds were not mentioned in this paper.

- Commondill, dill *Anethum graveolens* L., ssp. *hortorum* Alef.
- Leaf parsley *Petroselinum crispus* (Mill.) A.N. Hill., ssp. *crispum* convar. *crispum* leaves persil
- Summer savory, annual savory, savory *Satureja hortensis* L.
- Chervil *Antthriscus cerefolium* (L.) Hoffm., ssp. *cerefolium*
- Basil O*cimum basilicum* L.
- Garden cress - *Lepidium sativum* L.
- Marjoram (syn. Marjoram, maioran) *Majorana hortensis* Moench.
- Coriander (syn. white pepper) *Coriandrum sativum* L.

<u>Perennial vegetable plants</u>

<u>Perennials for roots</u>

- Horse-radish *Armoracia rusticana* Lam., sin. *Cochlearia armoracea* L., sin. *Armoracia lapathifolia* Gilb.
- Salsify (syn. cinnamon white) *Tragopogon porrifolius* L.

- Earthpuff, topinambur, Jerusalem artichokes, artichokes, (syn. turnip earth, earth apple, potato artichoke) *Helianthus tuberosus* L.

Perennial vegetable plants for bulbs, false stems, leaves.

- Egyptien onion, onions of Egypt (sin. rocambole onion, catawissa) *Allium cepa* L., f. *bulbiferum* Rgl.; *Allium cepa* f. *proliferum*
- Shallots (syn. Vlas, onion shallots *Allium ascalonicum*L.
- Japanese bunching onion, winter onion *Allium fistulosum* L.
- Great-header garlic, pearl onions (syn. Rakkyo) *Allium ampeloprasum* L. f. *homolense* A. et G.., sin *Allium chinense* L.
- Common chives, lawn onion (syn. Pure) *Allium schoenoprasum* L. Since the leaves are consumed, we believe it has a high content of nitrates.
- Chinese chives, chinese onion *Allium tuberosum* L.
- Garlic of Egypt (sin. rocambolle) *Allium sativum* ssp. *Sagitum*
- Asparagus *Asparagus officinalis* L. It believe that is high in nitrates content, like all young tissues.

The following species have a high content of nitrates Since there are consumed the leaves.

- Rhubarb (syn. Rhubarb, rabarber) *Rheum rhabararum* L., (sin. *R. undulatum* L., sin. *R. rhaponticum* L., sin. *R. Siibiricum* Pall.)
- Cynara artichoke *Cynara scolimus* L.
- patience dock, garden sorrel - (syn. Curly dock) *Rumex patientia* L.
- saudoch, Sorrel *Rumex acetosa* L.
- Dandelion *Taraxacum officinale* Web. (sin. *Taraxacum hortanse* Hort.)
- Nettle *Urtica dioica* L.

Species that follows, are not used in large quantities and there are no health risk to consumers.

- Lovage *Levisticum officinale* Koc.
- Tarragon *Artemisia dracunculus* L.
- Garden sage, sage (syn. Sage) *Salvia officinalis* L.
- Peppermint (syn. Good mint) *Mentha piperita* Huds.
- Millisbalm, common balm, melissa (syn. balm, thyme) *Melissa officinalis* L:
- Water cress, cress (syn. Cress pond) *Nasturium officinale* (L.) Brown., sin. *Roripa nasturium aquaticum* (L.) Hayek
- Rosemary (syn. Mirtin, dendrites) *Rosmarinus officinalis* L.
- French thime, thyme *Thymus vu*lgaris L.

4. CONCLUSIONS

Based on results of research carried out in our country show the following important conclusions:

1. Tomato, nitrates fall during the harvest (April 20th-15. June) phosphates grow, potassium has the lowest value at first harvest and the highest level to the second harvest (05.June).

2. The content of nutrients, carbohydrates, vitamins and pro-vitamins will vary depending on the cultivar.

3. Nitrates and nitrites contents are low in field culture compared with culture in greenhouse and solarium.

4. Existing products from the Romanian Market, from processing tomatoes have high nourishing value and contain nitrates.

5. At carrot both biochemical and agrochemical composition vary depending on the cultivar. There was a high nutritional value in all variants fertilized; the nitrate content is below the limits set out in Ord. No. 1 of January 3, 2002 the Ministry of Health. The largest amounts of $N\text{-}NO_3$ variants are fertilized with manure from chickens and $P\text{-}PO_4$ and K in variants fertilized with cattle manure. These elements are in greater quantities in the final harvest.

6. At cucumbers, the highest content of $N\text{-}NO_3$, $P\text{-}PO_4$ and K variants found in classic fertilized, especially the cultivar Mirabelle F1. Triumph cultivar F1 evidenced by the high content of K under the influence of fertigation; the highest content of dry matter and soluble carbohydrates found in organic fertilization, the higher acidity under the influence of classical fertilization and the highest content of vitamin C in variants with fertigation.

Bibliography

1. Anagnoste I., Câmpeanu Gh., Samata P., Neaţă Gabriela – 2011 – *Research on quality of carrot cultivars grown in Dobrogea.* Lucrări ştiinţifice U.Ş.A.M.V., Seria B, Vol. LV, pp.28-32. ISSN 1222-5339.

2. Câmpeanu, Gheorghe, Costache, Manuela-Adriana**,** Neaţă, Gabriela – 2012 - *Influence of fertilisation system on quality of cumcumbres grown in southern Romania.* 41st Annual Meeting ESNA, European Society for New Methods in Agricultural Research, Advances in agrobiology research and their benefits to the future, Book of abstracts from International Scientific Conference ESNA, Slovak Republic, 24-28 sept, Stara Lesna, pp. 111. ISBN 978-80-552-0855-8.

3. Câmpeanu Gh., Neaţă Gabriela, Teodorescu R, Basarabă A. – 2013 – *Research about the biological culture of carrot.* Universitatea din Craiova –

University of Craiova, seria Biologie, horticultură, Tehnologia prelucrării produselor agricole, Vol.XVIII (LIV). pp .59-64.

4. Chirică Barbu Mileva, Câmpeanu Gheorghe, Neaţă Gabriela, Costache Manuela, Atanasiu Nicolae, Fiscuci Gheorghiţa – 2012 - *Cercetări privind unele caracteristici de calitate la unele cultivaruri noi de tomate în sere şi solarii în zona de sud a ţării.* Abstract si prezentare poster la Simpozionul Ştiinţific cu participare internaţională „Dezvoltarea durabilă a agriculturii prin agroturism, protecţia consumatorului şi a mediului cu respectarea legislaţiei naţionale şi internaţionale", Universitatea Bioterra Bucureşti, Facultatea de Management Agroturistic, Focşani, 18-20 oct. 2012

5. Ciofu Ruxanda (coordonator), Nistor Stan, Popescu Victor, Chilom Pelaghia, Apahidean Silviu, Horgoş Arsenie, Berar Viorel, Lauer Karl Fritz, Atanasiu Nicolae. - 2003 - *Tratat de legumicultură.* Editura Ceres, Bucureşti.

6. Ciofu Ruxanda – 2014 - *Materiale nepublicate.*

7. Commoner B. – 1989 - Cercul care se închide. Editura Politică, Bucureşti,.

8. Fiscuci Ghiorghiţa, Neaţă Gabriela, Câmpeanu Gh., Costache Manuela – 2011- *Research regarding the biochemical and chemical contents of industralisation process of tomatoes* Lucrări ştiinţifice, U.Ş.A.M.V.B.,Seria B, Vol.LV, pg.59-62, ISSN 1222 – 5339

9. Gray J.I., Macdonald B., Pearson A.M., Morton I.D. – 1981 - Role of nitrite in cured meat flavor: A review. *J. Food Prot. 44*, 302–312

10. Ionescu-Şişeşti Gh., Staicu Ir. – 1958 - *Agrotehnica.* Editura Agro-Silvică, Bucureşti,

11. Lixandru Gh., Calancea L., Caramete C., Marin N., Goian M., Hera Cr., Borlan Z., Răuţă C. – 1990 – *Agrochime.* Editura Didactică şi Pedagocică, Bucureşti,.

12. Mureşan C., Tofană M., Socaci S., Salantă S. - 2012 - *Content Evaluation on Nitrates and Nitrites in Local and Imported Vegetables*, Bulletin UASVM Agriculture, 69(2),

13. Neaţă Gabriela – 2002 - *Agrochimie şi Bioologia solului* Editura Botech, Bucureşti,

14.Neaţă Gabriela, Stoian Ellena, Mocuţa Dorina, Temocico Georgeta, Fîntîneru Gina, Georgescu Mihaela – 2013 - *Nitrates and nitrites as sources of n-nitroso compound.* Roumanian Biotechnological Letters, Univerity of Bucharest, vol.18, No.5, 8583-8586.

15.Neaţă Gabriela – 2014 -.*Materiale nepublicate.*

16. Sebranek J.G. – 1979 - *Advances in the technology of nitrite use and consideration of alternatives*. Food Technol., 33, 58–62, 93

17. Simion G., Câmpeanu Gh., Vasile G., Artimon M., Catană L., Negoiţă M. – 2008 - *Nitrate and nitrite accumulation in tomatoes and derived products*. Roumanian Biotechnological Letters Vol. 13, No. 4, 3785-3790

18.- Sindelar J.J., Cordray J.C., Sebranek J.G., Love J.A., Ahn D.U. - 2007 b - *Effects of varying levels of vegetable juice powder and incubation time on color, residual nitrate and nitrite, pigment, pH, and trained sensory attributes of ready-to-eat uncured ham.* Journal of Food Science, 72 (6),, S388-S395

19. Sindelar J.J., Milkowski A.L., Sodium - 2011 a, - *Nitrite in Processed Meat and Poultry Meats: A Review of Curing and Examining the Risk/Benefit of Its Use*, American Meat Science Association, 3, 1-14

20. Şchiopu D. – 1997 - *Ecologie şi protecţia mediului.* Editura Didactică şi Pedagocică, Bucureşti, ISBN: 973-30-4848-0

21. Vasu Alexandrina – 1989 - *Componenţii în echilibru în circuitul sol-plantă –animal.* În - „Studii şi cercetări de biologie", seria Biologie vegetală, tom. 41, nr.1, Editura Academiei, Bucureşti.

22*** 1989 - *Nitratâ na priusadbenom uciastke.* În rev. „Zdarovie", nr. 4, Moskva,.

23*** Ordinul nr.1/2002 al Ministerului Sănătăţii.

PRELIMINARY RESEARCHES ON ECOLOGICAL RECONSTRUCTION BY REVEGETATION OF MINE WASTE DUMPS FROM CĂLIMANI MOUNTAINS

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Abstract. *The problem of ecological reconstruction of sulphur mine waste dumps from Călimani Mountains is complex due to the highly acid reaction of soils, with pH values ranging between 2.9 to 3.0. Encouraging results have been obtained only after liming with CaO (5 to 10 t/ha) and chemical fertilization with medium dosages, were, after 4 years from seeding, the herbaceous vegetation covers, in average, 50% of soil surface. Without liming and fertilization the revegetation with spontaneous species was inexistent, the soil being exposed to water erosion and the water with sulphuric acid cause serious damages to aquatic fauna.*

Keywords: ecology reconstruction, restauration, rehabilitation

1. Introduction

The ecological reconstruction of a mine waste dump (mine waste, ore flotation, solid fuel heating, domestic garbage and others) – results of economic activities and human being existence, is a complex process trough witch is installed herbaceous and/or wood vegetation on a surface with a low natural fertility, more or less suitable for plant growing in order to fixate the soil, environmental protection, economic valorization and landscaping function. This term has various names such as restauration, recultivation, revegetation, reverdissment, rehabilitation, reclamation and others.

Amongst the methods of ecological reconstruction known it is used mainly the reforestation one because is the ultimate goal for all areas suitable for forests.

In some cases, when the mine waste dumps are composed by pulverulent materials, until reforestation is required a fast revegetation in order to stop the wind and water erosion.

Thus, on mine waste dumps the revegetation can be a universal "panacea", cheaper compared to reforestation that is carried out only in a few cases and with big expenses. The mine waste dumps from different origin are real air and soil pollution outbreaks [1, 2].

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In order to fix this situation, before using reforestation as a final consolidation method, is considered that the rapid revegetation is, as a first stage, the best method to prevent the active erosion occurring on slopes and on the top flat part of mine waste dump. The success of revegetation on slopes and top part before beginning of erosion process depends mainly to the installation and survival of herbaceous vegetation for many years, until reforestation. It can be considered that there is a competition between the factors that are determining the erosion and the installation of vegetation.

In the revegetation process the most important role is held by the seed mixtures, the species composing them have to meet a few mandatory conditions as:

- immediate and long term adaptation to the soil and local climate condition;
- rapid installation in order to prevent the wind and water erosion, after shaping the terrain, and the consolidation of protective vegetation;
- protection of the species that are installing slower in the first vegetation stages but are more persistent (perennial);
- providing the fertilizers and the participation of nitrogenous fixing species such as the species from *Leguminosae* (*Fabaceae*) family;
- installation in successive stages of seeded species similar to natural revegetation, meaning annual, biannual and perennial species;
- achieving an economic value for seeded vegetation for forage production, medicinal flora, honey production etc., for sports grounds and many others in addition to the main eco-protective function;
- easy seeding on rough terrains composed by pulverulent materials.

The making process of seed mixtures that are complying with so many demands is more complicated than the forage production on arable lands.

In the seed mixtures there must be introduced annual species like cereals that can fixate rapidly the soils layers and ensure a protection against drought and insolation for species of grasses and legumes more sensitive in the early growth stages. On pulverulent soil layers with water shortages is recommended the inclusion in mixture of cultivated *Amarantaceae* species that ensures a greater protection for sensitive species in the early growth stages [3]. Another problem for mixtures is seed dilution with sand, mainly for a better manual seeding on the steep slopes. One of the solutions, maybe the best one, is the seed mixture with chemical fertilisers providing both the dilution and the fertilization.

The studies carried out have indicated that is possible to mix seeds with chemical fertilisers, the mixture validity lasting one year since making [4, 5].

The results obtained are supporting the importance of complex seed - chemical fertiliser mixtures for a various soil and climatic conditions with a known validity term.

A particular problem is the ecological reconstruction of the mine waste dumps located in protected areas, such as the ones resulted from the sulphur exploitation in Călimani Mountains.

In the protected areas it is forbidden the introduction of new species and even of new variety of existing species. Gathering seeds from spontaneous flora is a utopia, because the seeds gathered will not cover even 1 % from the Călimani bare land. Also, in this protected areas it is strictly forbidden the chemical fertilization, although this products are containing the main nutrient elements, Nitrogen, Phosphorus and Potassium, required by herbaceous and wood vegetation for growing.

Without the nutrients present in organic and chemical fertilisers the vegetation cannot emerge on a bare ground without natural fertility, just like in the case of waste dumps from Călimani Mountains. Providing of organic fertilisers from local households is not possible, because it is not for sale and secondly due to the long transporting distance (40-50 km) and the quantities required per hectares are significant (30-50 tones/ha).

We ask ourselves what is to be done in this situation. Should we wait for a number of decades for natural restauration or should we intervene in order to stop, as much as possible thought revegetation, the erosion of those waste dumps and the pollution of all downstream water for kilometers around leading to the disappearance of aquatic fauna due to the acidity and the high content of harmful elements.

Our opinion is that we have no choice; we should act immediately to stop the erosion with all available methods (barrages etc.) after hydro ameliorative measures followed by seeding for fixing and consolidation of residual materials resulted from mining activities.

Those "open wounds" without protective vegetation are more polluting and dangerous for the environment and biodiversity than the usage for seeding and restoration of some variety of grass and legume species present in that area along with the liming and chemical fertilization with a limited time effect that can make possible the revegetation, providing a protective role for soil and the spontaneous species that will appear naturally on improved areas. Thereby the seeded species more "pretentious" towards the nutrients, with a shorter presence in sward, are gradually replaced by the spontaneous species from local flora, more adapted to these extreme conditions and, in this way, on long term, the biodiversity will be maintained.

2. Material and methods

The mine waste dumps from Călimani National Parc are similar, from the ecological reconstruction point of view, to the ones from Bozanta and Meda lakes, located near Baia Mare. The soil layers physical and chemical characteristics, the highly acid reaction, low content in nutrients and the toxic effect of mobile Aluminium are the main similitudes between the sites.

In August and November 2009 have been taken soil and residual materials samples from the mine waste dumps from Călimani Mountains, the samples have been analysed by the Office of Pedological and Agrochemical Studies from Brasov according to national methodology (Table 1).

Table 1. The properties of soil and residual materials samples from Călimani waste dumps

Nr	*Localization*	*Sample depth*	*pH in H_2O (indices)*	*Humus (%)*	*Mobile P (ppm)*	*Mobile K (ppm)*	*Degree of base saturation (V%)*	*Mobile Al (me)*
Puturosu waste dump								
1	New material	Surface	2,9	0,12	2,0	6,0	7,2	3,256
2	New material	Surface	2,7	0,17	3,2	8,0	7,9	4,202
3	Old material	0 – 15	3,9	1,23	13,0	57,5	16,3	11,638
4	Old material	15 – 30	3,9	0,79	15,5	54,0	16,8	14,586
Pinu waste dump								
5	New material	Surface	3,5	0,35	5,8	18,0	34,2	4,400
6	Old material	0 - 15	3,8	0,61	14,1	77,5	12,5	19,800
Warping								
7	Pinu Barrage	Surface	3,0	0,47	12,5	18,0	18,3	13,332
8	Haita Dumitrelu	Surface	3,3	2,12	14,1	22,0	19,7	9,570

The residual materials found within Puturosu waste dump have a high acidity (pH 2.9), a low content of humus, phosphorus, potassium and others minerals that makes impossible the growth of plant species without intervention with lime and fertilisers.

Settled residual materials, after 15 to 20 years of in-depth leaching, have the acidity higher by one unit, reaching pH values of 3.8 and 3.9, favouring the installation of a few pioneer species spread in isolated clumps. The most present species found in this areas is *Deschampsia flexuosa* followed by *Deschampsia caespitosa* and in patches spruces (*Picea abies*) that are dying out within several years of colonisation, when the roots are reaching the bottom residual materials layers that are accumulating year by year greater quantities of mobile Aluminium (up to 11 – 20 me/100 grams of soil) very toxic for plant species.

Thought water erosion significant quantities of residual materials have been transported from the waste dump slopes to the valleys and barrages. The residual materials deposited in valleys and barrages are also high acid (pH values of 3.0 to

3.3) and are having a high mobile Aluminium content of 9 up to 13 milligram equivalents / 100 grams of soil.

In areas with deposited residual materials the humus content is higher (0.5 – 2%) and minerals content is higher also, mostly originated from upstream forests soils.

The residual materials from Dumitrelu waste dump have better agrochemical characterises compared to the ones from Pinu Barrage, and are being recommended as "fertile" layer, in case of need, to cover more acid soil layers like the ones found in Puturosu waste dump.

Considering the urgent need of ecological reconstruction measures by revegetation, with the support an approval of the constructor, a German firm, the Research and Development Institute for Grasslands had initiated a simple field experiment with liming and seeding in 8 different locations: 5 on Puturosu waste dump (3 near the old headquarters and 2 at the processing station); 2 on Pinu waste dump and one at Haita Dumitrelu according to constructor`s recommendations.

Experimental plots:

A. Control
B. No liming
C. Liming with 5 t/ha (CaO)
D. Liming with 10 t/ha (CaO)

Seeding

1. Fall 2009 in 22 September, taking a chance because it was not within the recommended seeding period (up to 20 August);

2. Spring of 2010, just after the snow has melted and the weather is warmer.

B, C and D plots have been fertilised with chemical fertilisers in 2009, 2011 and 2013 with 75 kg/ha N, 75 kg/ha P_2O_5 and 75 kg/ha K_2O.

The surface of a plot is of 37,5 m^2 (7,5x5 m) and a parcel has 6,25 m^2 (2,5x2,5).

After the experiment started (in 22 September 2009), the first observation have been carried out in November and it was noticed that the seeding had a good result on limed plots and almost no effect on plots not limed.

The complex mixture used was composed by 20 % grasses and perennial legumes, 13 % by cereals and 67 % chemical fertilisers (NPK).

3. Results and discussions

Soil samples (0-15 depth) from each experimental plot have been taken after 4 years since the experiment started (Table 2).

Table 2. Agrochemical proprieties of soil layers following 4 years of liming and fertilization

Plot	*Depth (cm)*	*pH in H_2O*	*Ah (me)*	*SB (me)*	*VAh (%)*	*Humus (%)*	*NI*	*P-AL ppm*	*K-AL ppm*
A. Control	0 – 15	2,9	12,9	1,5	10,4	0,56	0,05	6,0	54,0
	15 - 30	3,9	26,8	3,8	12,4	1,19	0,13	11,5	89,0
B. Chemical fertilization, over seeding	0 – 15	3,0	11,4	1,2	9,5	0,35	0,03	15,5	46,0
	15 - 30	3,9	27,2	3,8	12,2	1,40	0,17	23,8	120,0
C. liming 5 t/ha CaO, chemical fertilization, over seeding	0 – 15	4,3	5,4	6,0	52,6	0,63	0,33	21,0	46,0
	15 - 30	4,5	14,9	12,9	46,4	1,05	0,48	15,0	105,0
D. Liming 10 t/ha CaO, chemical fertilization, over seeding	0 – 15	4,9	8,3	19,0	69,5	0,98	0,68	22,0	132,0
	15 - 30	5,6	4,8	20,1	80,7	1,55	1,67	24,8	168,0

It is noticed the high acidity of plots not limed (pH 2.9 – 3.9) and a visible improvement of limed plots, after liming the pH values are increasing up to 4.3 – 5.6.

As a result of leaching, on all experimental plots, the acidity is higher on 0-15 depth than on 15-30 one.

The hydrolytic acidity (Ha) and the sum of bases in exchangeable forms (SB) are improved as a result of liming.

The degree of base saturation (VAh) on plots not limed is 11.1% and over 5 times higher (62.3 %) on limed plots.

As well, the content in mobile Phosphorous (P-Al) and mobile Potassium (K-Al) is higher on limed and fertilised plots.

These improvements, meaning reducing of acidity and the fertilization have made possible the success of seeding (Table 3).

Table 3. Coverage degree and botanical compositions of experimental plots (Călimani, 2013)

Plot	*Coverage degree (%)*			*The principal species presented in the order of participation in sward*
	Seeded		*Mean*	
	Fall	*Spring*		
A. Control	X	X	0	*Deschampsia flexuosa,* 2 pioneer herbs
B. Chemical fertilization, over	6	10	8	*Deschampsia caespitosa, Deschampsia flexuosa, Festuca*

seeding				*rubra*
C. liming 5 t/ha CaO, chemical fertilization, over seeding	38	58	48	*Festuca rubra, Dactylis glomerata,* *Lotus corniculatus, Trifolium repens,* *Festuca pratensis, Phleum pratense,* *Deschampsia caespitosa, Deschampsia flexuosa, Lolium perenne, Poa pratensis, Salix caprea, Picea abies* etc
D. Liming 10 t/ha CaO, chemical fertilization, over seeding	47	65	56	

On A plots, after 4 years of experimentation and over 5 years since the modeling of soil layers resulted from the sulphur mine, there are present only 2 clumps of *Deschampsia flexuosa* species in all of the 8 places (totalling 100 square meters), extremely low coverage with vegetation proving that the revegetation does not happen naturally.

As a result of fertilization, without liming, in B plots the coverage degree with vegetation is very low (8 %) the species present are *Deschampsia caespitosa*, *Deschampsia flexuosa* and a few clumps of *Festuca rubra*, in this case the revegetation period is very long.

After fertilization and liming (C and D plots) the coverage degree with vegetation is 52 %, 6 ½ higher than in B plots that had not been limed. On limed plots the seeding in spring leaded to coverage of 62 % meaning with 20 % higher that the plots seeded in fall (42 %).

The results obtained are confirming the possibility of revegetation of the waste dumps with restrictive vegetation conditions using two simple methods: liming and fertilization.

CONCLUSIONS

The ecological reconstruction by revegetation of mine waste dumps from Călimani Mountains is a complex problem that requires a fast solving, because the natural revegetation is very slow.

As a result of liming (5 to 10 t/ha CaO), for increasing initial pH values of soil layer, and fertilization it makes possible the growth of seeded species on a soil with a pH ranging between 4.3 and 5.6 and with medium concentration of nutrients.

After the vegetation has growth (installed), on limed and fertilized plots, the coverage degree resulted after 4 years at 50 % leading to a diminishing of soil erosion processes and increasing the pedological processes.

References

[1]. Harris A.J., Birch P., Palmer J.P., *Land restoration and reclamation* (Wesley Longman Ltd., Singapore, 1996).

[2]. Dumitru M., Blaga Gh., et al., *The recultivation of the mining exploatation degraded lands from Oltenia Coal Basin*, (Transilvania Press publishing house, Cluj – Napoca, 1999).

[3]. Maruşca T., Mocanu V., Hermenean I., Blaj V.A., Filip Monica, Maruşca S.,: *Research regarding estabilishment of the sown grassland for the antierosion protection of a thermal power station ash dump*, (EGF, Grassland Science in Europe) **Vol. 14**, p. 173-176, Brno, Czech Republic (2009)

[4]. Maruşca T. et al., *Principii şi metode noi de restaurare ecologică a haldelor de zgură şi cenuşă de la termocentrala pe lignit – Braşov*, (Simpozionul "Managementul Mediului Urban şi Industrial în contextul integrării europene", Editura Universităţii Transilvania din Braşov, 2000), p. 43-49

[5]. Maruşca T., Dincă L., *Contributions to herb and wood species range improvement for the rehabilitation of slag and waste heaps from coal – power – stations*, (Proceeding of the Symposium "Restoration Ecology" University of Agricultural Sciences Timişoara, September 20-23, Editura Orizonturi Universitare, Timişoara, 2001) p. 89-93

LONG TERM EFFECT OF IMPROVEMENT METHODS ON SUBALPINE DEGRADED *Nardus stricta* L. GRASSLANDS

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Abstract. *Researches have been carried out at the Research Station for Mountain Grasslands from Blana, Bucegi, located at 1.800 m altitude (subalpine floor) in order to determine the effect of different improvement methods on degraded Nardus stricta grasslands. With the dry matter yield (DM) there have been made accurate analysis of floristic composition and fodder quality after 19 years since the improvement by different methods. The researches have highlighted the long term effect of improvement methods (organic and chemical fertilisation, reseeding, over-seeding and liming) a subject not so well studied in present time in Romanian Carpathians. The best improvement method was the liming up to 2/3 hydrolytic acidity, over-seeding after harrowing at 1 up to 2 cm deep and organic or organic and chemical fertilisation. In this plot Nardus stricta was replaced by valuable species like Festuca nigrescens, Agrostis capillaris and Poa pratensis. Also the participation of Trifolium repens has grown up to 20-25 %. As a result, the pastoral value increases to 68, the DM yield triples and has a crude protein content of approximately 12 % and a lower fibre and lignin proportion thus increasing the fodder digestibility.*

Keywords: floristic composition, improvement methods, *Nardus stricta* grasslands, quality of fodder.

1. Introduction

Researches concerning the influence of improvement methods on floristic composition and fodder quality from mountain grasslands are numerous in Romanian Carpathians, but mostly of them have had results only for 3 to 5 years, according to usual experimental protocols (Puscaru *et all.*, 1956, Barbulescu and Motca, 1983). Results over longer periods are generally fewer and almost absent on higher grasslands such as the subalpine ones from Carpathians, located in *Pinus mugo* floor at 1800 m altitude (Maruşca *et all.* 2010). In this climatic

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conditions and vegetation period at higher altitude, the evolution of sward and fodder quality in relation with the improvement methods are much more different than the lower grasslands with favourable conditions.

For this reason it has been raised the problem of researches carried out over longer periods on the degraded *Nardus stricta* grasslands from high mountain region, that require improvement.

2. Material and method

The experience was carried out at the Research Station for Mountain Grasslands from Bucegi Mountains, at 1.800 m altitude in subalpine floor on degraded *Nardus stricta* grassland (40 % *N. stricta*).

Experimental plots are:

A Factor: Fertilization

1. *Chemical fertilisation*

Phase I: 1996 - 50 kg /ha P_2O_5 +50 kg/ha K_2O;
1997 - 50 kg /ha P_2O_5 +50 kg/ha K_2O;
1998 - 50 kg /ha P_2O_5 +50 kg/ha K_2O;

Phase II: 2004 - 150 kg /ha N + 100 kg /ha P_2O_5 +100 kg/ha K_2O;
2005 - 100 kg /ha N;
2006 - 50 kg /ha N;

Phase III: 2012 - 150 kg /ha N + 100 kg /ha P_2O_5 +100 kg/ha K_2O;
2013 - 100 kg /ha N;
2014 - 50 kg /ha N;

2. *Chemical and organic fertilisation*

Phase I: 1996 - 150 kg /ha N + 50 kg /ha P_2O_5 +50 kg/ha K_2O;
1997 - 100 kg /ha N + 50 kg /ha P_2O_5 + 50 kg/ha K_2O;
1998 - 50 kg /ha N + 50 kg /ha P_2O_5 +50 kg/ha K_2O;

Phase II: 2004- paddocking 5 nights one cow/6 m^2 + 100 kg /ha P_2O_5;

Phase III: 2011 - paddocking 5 nights one cow /6 m^2 + 100 kg /ha P_2O_5;

3. *Organic fertilisation*

Phase I: 1995 - paddocking with one sheep/1 m^2 for 5 nights;

Phase II: 2004 - paddocking with one sheep/1 m^2 for 5 nights + 100 kg /ha P_2O_5;

Phase III: 2011 – paddocking with one cow/6 m^2 for 5 nights + 100 kg /ha P_2O_5;

B Factor: Sward

1. Natural (*Nardus stricta* 60 %);
2. Over-seeding in 1996, after spraying in 1995 and harrowing (1-2 cm);
3. Reseeding in 1996 after spraying 1995 and milling (10-12 cm);

C Factor: Liming

1. No liming;
2. Liming up to 2/3 hydrolytic acidity (approx. 7,5 t/ha CaO)

The harvesting of experimental plots for determining the yield and taking the samples for chemical analyses were done once a year, at a beginning of August on 2 square meters from the total 18 m^2 of each experimental plot, the rest of the surface was grazed by dairy cows. In this way, by grazing, trampling and animal manure we have get closer to the reality from those grasslands, compared to the usual system of harvesting by mowing and the presentation of the results with approximate conclusions for the grazing regime.

We would like to mention that the over and reseeded species (*Phleum pratense* and *Festuca pratensis*) have not produced seeds for auto-seeding, so it can be noticed their longevity in sward.

3. Results and discussion

Dry matter yield

For starter it was calculated the factors influence on dry matter yield (DM), especially for the ones with a signification (Table 1).

Table 1. Influence of fertilization (A), liming (C) and combination sward type – liming (BxC) on DM yield, Blana – Bucegi, 2014

Factors	DM yield		Difference	Signification
	t/ha	%	+ -	
A. Fertilization				
A1 Chemical	1,42	100	Control	-
A2 Organic + chemical	2,45	173	1,03	**
A3 Organic	3,11	219	1,69	***
C. Liming				
C1 no liming	1,99	100	Control	-
C2 liming up to 2/3 hydrolytic acidity	2,67	134	0,68	***
B (grassy carpet) x C (liming)				
B1 natural x C1	1,76	100	Control	-
B2 over-seeded x C1	2,29	130	0,52	
B3 re-seeded x C1	1,91	108	0,15	
B1 x C2	3,00	170	1,23	***
B2 x C2	2,81	159	1,05	***
B3 x C2	2,20	125	0,43	***

DL:	A	C	B x C
5 %	0,50	0,32	0,56
1 %	0,80	0,43	0,75
0,1 %	1,29	0,57	0,98

From showed data it results that the organic fertilisation in 3 stages, after 19 years of influence is with 219 % higher than the chemical fertilisation and the liming ensures a DM yield with 134 % higher compared to the plots not limed, both factors are very significant.

Floristic compositions

As a result of improving the sward by liming and sowing, in 1996, followed by three stages of fertilisation the grassy carpet had undergone profound modifications (Table 2).

Table 2. Floristic composition of the experimental plots (Blana Bucegi, 2014)

Species / Plot	111	211	311	112	212	312	121	221	321	122	222	322	131	231	331	132	232	332
Grasses total	**76**	**65**	**65**	**68**	**63**	**55**	**85**	**70**	**78**	**88**	**68**	**62**	**85**	**75**	**72**	**80**	**70**	**70**
Phleum pratense	-	10	3	-	3	2	-	18	18	28	30	17	-	7	13	2	13	20
Festuca pratensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Nardus stricta	4	-	-	1	-	-	2	-	-	-	-	-	3	-	-	-	-	-
Festuca nigrescens	6	8	11	27	14	-	5	18	10	20	10	5	10	4	5	8	10	10
Agrostis rupestris	13	+	3	2	-	5	12	5	4	7	3	1	12	2	4	8	4	1
Agrostis capillaris	4	7	5	-	-	4	15	23	32	20	17	27	18	35	40	45	32	23
Phleum alpinum	2	4	4	4	2	3	+	+	3	-	-	5	2	6	4	3	1	4
Poa media	6	5	7	2	1	2	10	5	5	3	3	1	13	9	2	10	6	4
Poa pratensis	+	25	27	32	45	37	-	2	3	5	-	7	-	3	3	-	2	7
Anthoxanthum odoratum	4	2	+	+			8	-	-	-	-		5	1	1	1	+	+
Deschampsia flexuosa	37	4	5	-		2	33	5	3	5	5	1	22	9	+	2	2	1
Legumes *Trifolium repens*	**4**	**20**	**17**	**11**	**22**	**25**	**+**	**20**	**10**	**5**	**17**	**23**	**3**	**15**	**14**	**7**	**23**	**17**
Other species	**20**	**15**	**18**	**21**	**15**	**20**	**15**	**10**	**12**	**7**	**15**	**15**	**12**	**10**	**14**	**13**	**7**	**13**
Potentilla aurea	8	1	2	5	1	1	10	1	2	2	1	2	9	2	6	4	1	2
Ligusticum mutellina	10	7	5	9	4	7	4	6	3	4	6	2	1	2	2	3	2	2
Ranunculus montanus			1						+	+					1			1
Polygonum bistorta												2					1	
Hieracium aurantiacum	+	+	1	1	+			+	+	+		+	1	3	1		1	
Campanula abietina								1										
Campanula napuligera	1	1	2	4	1	3	1		+	1	1	+	1	1	1	2	1	1
Viola declinata									+						1	1		
Taraxacum officinale	1	4	6	2	4	8		2	7	+	5	7		2	2		2	6
Rumex acetosella		1	1		2	1						1						
Achillea setacea		1			2													
Alchemilla vulgaris			+		1					+	2	1			+	1		

After 19 years since seeding it can be noticed the presence of *Phleum pratense* species, Favorit variety with a participation of 17-30 % in over-seeded and limed plots without auto-seeding, this prove the exceptional longevity of this variety in extreme climatic conditions.

Likewise it can be noticed the appearance and the spreading of *Poa pratensis* species in natural sward and *Agrostis capillaris* species in the plots harrowed at 1-2 cm deep in order to over-seeding and milling at 10-12 cm for reseeding.

Longevity of some seeded species such as *Phleum pratense* and the appearance and spreading of a few valuable spontaneous species as *Poa pratensis, Agrostis capillaris* and *Festuca nigrescens* is due to fertilisation, liming and rational utilisation.

Pastoral value of the experimental plots and the factor influence are presented in table 3.

Table 3. Pastoral value (PV) of experimental plots (Blana Bucegi, 2014)

Plot	Pastoral value	Appreciations	Differences	%
111	23	Low	Control 111	100
211	60	Good	+ 37	261
311	53	Good	+ 30	230
112	55	Good	Control 112	100

212	61	Good	+ 6	111
312	57	Good	+ 2	104
121	23	Low	Control 121	100
221	66	Good	+ 33	287
321	62	Good	+ 29	270
122	64	Good	Control 122	100
222	68	Good	+ 4	106
322	66	Good	+ 2	103
131	29	Average	Control 131	100
231	53	Good	+ 24	183
331	60	Good	+ 31	207
132	50	Good	Control 132	100
232	63	Good	+ 13	126
332	65	Good	+ 15	130
Mean of factors				
100	41	Average	Control 100	100
200	62	Good	+ 21	151
300	61	Good	+ 20	149
010	52	Good	Control 010	100
020	58	Good	+ 6	112
030	54	Good	+ 2	104
001	48	Average	Control 001	100
002	62	Good	+ 14	129
Experience Mean				
000	55	*	*	*

The best plot, regarding the pastoral value, was 222 meaning the organic and chemical fertilisation, over-seeding and liming, registering 68 points followed by 221 and 322 plots with 66 points.

From point of view of factors influence the highest growth was recorded in case of combined fertilisation (organic plus chemical products) and organic with an average increase of 150 % compared to chemical fertilisation, followed by liming with 129 % compared to the plot not limed and over-seeded with 112 % compared to natural sward.

Chemical composition of fodder

Fertilisation system (factor A) had the greatest influence on the chemical composition of fodder from studied grasslands (Table 4).

Table 4. Chemical composition of fodder in relation with the fertilization system Blana – Bucegi, 2014

Specification	Fertilisation system (Factor A)	Content g/100g	%	Difference + -	Signification
Crude protein (CP)	1. Chemical	9,68	100	control	
	2. Organic + chemical	10,05	104	+0,37	
	3. Organic	11,85	122	+2,17	**
Ash	1. Chemical	6,08	100	control	
	2. Organic + chemical	6,74	111	0,66	**
	3. Organic	7,56	124	1,48	***
Crude cellulose (CC)	1. Chemical	39,34	100	control	
	2. Organic + chemical	38,96	99	-0,38	
	3. Organic	36,33	92	-3,01	oo
ADF	1. Chemical	41,87	100	control	
	2. Organic + chemical	41,31	99	-0,56	
	3. Organic	39,26	94	-2,61	oo
ADL	1. Chemical	5,61	100	control	
	2. Organic + chemical	5,24	93	-0,37	o
	3. Organic	4,90	87	-0,72	oo

DL:	CP	Ash	CC	ADF	ADL
5 %	1,15	0,37	1,76	1,59	0,33
1 %	1,75	0,56	2,67	2,40	0,51
0,1 %	2,80	0,90	4,30	3,86	0,82

Thus, as a result of organic fertilisation, the fodder has the highest content of crude protein (11,85 %) more with 122 % compared to chemical fertilisation. It is the same in the case of ash content, higher in plots organic plus chemical fertilised and with organic manure. The lowest content of CC, ADF and ADL is present in the case of organic fertilisations compared to chemical fertilisation, plots that are presenting a superior forage quality.

Fertilisation type and the liming had also an important influence as well for the crude protein, yield per hectare. CP from improved grasslands is greater than the one from control plot (Table 5), with an important benefit for animals, by ensuring a good energy - protein balance in fodder (Nichita, 1984).

Table 5. Influence of fertilisation and liming on crude protein yield, Blana-Bucegi, 2014

Specification	CP yield		Difference + -	Signification
	kg/ha	%		
A. Fertilization				
1. Chemical	146	100	control	
2. Organic + chemical	252	172	208	***
3. Organic	320	219	276	***
DL 5 % = 55 DL 1 % = 83 DL 0,1 % = 133 kg/ha				
C. Liming				

1. No liming	205	100	control	
2. Liming up to 2/3 Hidr. Acid.	275	134	70	***
DL 5 % = 33 DL 1 % = 44 DL 0,1 % = 59 kg/ha				

A final analysis was focused on organic matter digestibility (OMD), in this case the organic fertilisation and liming have provided a yield with 104 -111% higher compared to control plot (Table 6).

Table 6. Digestibility indices of OMD in relation with fertilisation and liming, Blana-Bucegi, 2014

Specification	OMD		Differences	Signification
	indices	%	+ -	
B. Fertilization				
1. Chemical	44,38	100	control	
2. Organic + chemical	45,62	103	1,24	
3. Organic	49,16	111	4,75	*
DL 5 % = 3,26 DL 1 %= 4,95 DL 0,1 % = 7,95				
C. Liming				
1. No liming	45,38	100	control	
2. Liming up to 2/3 Hidr. Acid.	47,39	104	2,01	*
DL 5 % = 1,89 DL 1 %= 2,55 DL 0,1 % = 3,40				

Shown data are highlighting the known results about the importance of organic fertilisation and liming on grasslands from high mountain area on the quality of fodder.

CONCLUSIONS

1. Dry matter yield of improved grasslands was stimulated by organic and combined fertilisation especially on plots limed, with a natural sward or over-seeded.
2. Generally speaking, the floristic composition of studied grasslands, after almost two decades of factors influence, have highlighted the longevity of sown species *Phleum pratense*, the appearance and dominance from spontaneous vegetation of *Poa pratensis* species in present sward and of the species *Festuca nigrescens* and *Agrostis capillaris* in over and reseeded plots and the stimulation of *Trifolium repens* species in limed plots organic fertilised.
3. The highest pastoral value was registered on the plot fertilised in a combined system (organic plus chemical) and organic, on over-seeded and limed plots.
4. The fodder quality expressed by the protein and fibres content in with a direct effect on digestibility of feeds, has underlined the long term effect of paddocking and liming.

5. The degraded subalpine *Nardus stricta* grasslands can be improved in a first stage by liming, over and reseeding, were is possible; a initial chemical fertilisation followed by organic one by paddocking and after a conversion period, the grasslands can be transferred to a biological agriculture.

REFERENCES

1. Bărbulescu, Motcă Gh., 1983, Păşunile munţilor înalţi, Ed. Ceres, Bucureşti
2. Maruşca T., Bărbos M.I., Blaj V.A., Cardaşol V., Mocanu V., Rusu M., Secelean I., 2010, Tratat de reconstrucţie ecologică a habitatelor de pajişti şi terenuri degradate montane, Ed. Universităţii ”Transilvania”, Braşov
3. Puşcaru D., Puşcaru-Soroceanu E., Paucă A., Şerbănescu I., Beldie Al., Ştefureac Tr., Cernescu N., Saghin N., Creţu V., Lupan L., Taşenco V., 1956, Păşunile alpine din Munţii Bucegi, Ed. Academiei Republicii Populare Române
4. Nichita Georgeta, 1984, Nutriţia, factor fundamental în rentabilizarea producţiei animaliere, Ed. Facla, Timişoara

RESEARCH REGARDING THE IMPORTANCE OF THE IRRIGATION IN THE SUSTAINABLE AGRICULTURE SYSTEM FROM NORTH WESTERN PART OF ROMANIA

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Abstract. *The paper is based on the research carried out during 1976-2014 in Oradea, in a long term trial at ten different crop.*

The melioration crop rotation with alfalfa, the fertilization system with manure and optimum chemical fertilization determined to maintain the structured degree in the irrigated variant on the level of the crop rotation with unirrigated wheat- maize

Soil water reserve on irrigation depth decreased bellow easly available water content every year and in the 30 % from years even bellow wilting point.

The irrigation improved the microclimate conditions and the optimum water consumtion can be assured using the irrigation, only .

Irrigation determined the increase of the yield level in average with 39 % (wheat) to 127 %(maize for silo); yield stability (standard deviation) improved with 8,7 % (sunflower) to 50,4 % (maize for silo). Yield quality and water use efficiency were improved, too, in the irrgated conditions.

The correlations quantified in the soil-water-plant- atmosphere system sustain too the importance of the irrigations in the sustainable agriculture system from Western part of Romania, too.

Keywords: irrigation, microclimate, sustainable agriculture, yield, water use efficiency.

Introduction

The concept of sustainable agriculture appeared in the sixth decade of the last century as a response to the enviromental pollution. The resort “we have one land who must be protected” at The United National Conference for Human Environment from Stockholm in 1972 and “Broundland Report” of ONU Conference on Enviroment and Development from Rio de Janeiro was the crucial moments in definition of the development sustainable concept, especially sustainable agriculture. The researchers who published about this problem were

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Tinbergen (1956), Odum, 1971, Clarck and Mun, 1986, Hall, 1995 and all (referenced by Puia and Soran, 1999).

In Romania, in 1999 there was a reference moment regarding this problem; Hera.Cr, organized the symposium ”The performant sustainable agriculture”, scientifical manifestation of Plant Crop Section belonged to ASAS “Gheorghe Ionescu Şişeşti”. From many and interesting papers referenced and published the symposium those written by Puia and Soran, Toncea, Săulescu, Iliescu, Sin, Picu (Hera 1999). Budoi and Penescu (1996), Guş and all (1998) in the treatises of Soil Management had an important contribution in knowledge of this concept, too. All these papers sustain the crop rotation like central pivot and presume a variating structure of crops. In this system, the organic fertilization is very important, the chemical fertilization can be used with moderate rates, the soil tillage must be right executed, the plants protection is realised by integrated management; all this thinks assured the conservation of the soil, water and biodiversity reserve and obtaining an ecological and profitable yields.

If it’s used correctly, the irrigation is a component of sustainable agriculture (Doorembos and Kassam, 1986, Doorembos and Pruitt, 1992).

The papers starts from this reason and through the researches concerning of soil structure, soil moisture stress, the irrigation influence upon microclimate and plants water consumption, the level, stability and quality of the yield , and the water use efficiency demonstrate that irrigation is an important component of sustainable agriculture system from western Plain of Romania.

MATERIAL AND METHOD

The research were obtained in Oradea in the north part of Crişurilor Plain during 1976-2014, in a long term trial on preluvosoil.

On the ploughed depth, the preluvosoil has a hydraulic conductivity with big value, median on 20-60 cm depth and very small below 60 cm depth. On 0-20 cm depth the soil is small settled (BD = 1.41 g/cm^3) and very settled on the irrigation depth of the crops studied and on the depth (0-150 cm) for soil water balance. Field capacity (FC) is median on the all soil profile and wilting point (WP) has a median value till 80 cm depth and big value below this depth. Easily available water content (W_{ea}) was established by formula (Botzan 1966, Grumeza and all, 1989): W_{ea} = WP + 2/3 (FC - WP);

Soil reaction is low acid, the humus content (1.8 %) is small and the total nitrogen content (0,127-0,156 ppm) is small- median; the mobile potassium content is small – median, too. The annual fertilization with the doses specifical for irrigated crops increased the phosphorus content from 22.0 ppm to 150.8 ppm.

The water sources for irrigation is water ground (15 m depth). The irrigation water has a low natrium content (12.9 %), the salinization potential is low (CSR = -1.7) and SAR index (0.52) is low too.

The irrigation equipment of the research field permitted to measure exactly and to distribute uniformelly the irrigation water.

Soil moisture determined ten to ten days maintaining the soil water resrve on irrigation depth (0-50 cm for wheat and bean; 0-75 cm for maize, soybean, sunflower, potato, sugarbeet, alfalfa 1st year, maize for silo; 0-100 cm for alfalfa 2nd year).

Domuţa Climate Index was calculated after following formula: ICD = $\frac{100W + 12{,}9A}{\sum t + Sb}$;

were: W = water (irrigation, rainfalls, water ground);
A = air humidity, %;
Σt = the sum of daily average temperature, °C;
Sb = sun brilliance, hours

The climate carachterization after ICD value is: < 3 exces droughty; 3.1-5.0 very droughty; 5.1-7.0 droughty; 7.1-9 median droughty; 9.1-12 median wet; 12.1-15 wet I; 15.1-18 wet II; 18.1-25 – wet III; > 25 exces wet.

The crops technologies wish to be the optimum one, for this part of the country. Crop rotation used were: alfalfa 1st year – alfalfa 2nd year- maize – bean – wheat – soybean – sugarbeet – sunflower – potato. The fertilization system had a rate of 40 t/ha manure for sugarbeet and potato and annual medium rate on crop rotation of N 140 kg/ha a.s., P 110 kg/ha a.s. and K 90 kg/ha a.s. were used.

The structure of soil was determined with Cseratzki method. Plants water consumption was determined by soil balance; the depth balance was 0-150 cm.

RESULTS AND DISCUSSIONS

The influence of irrigation on soil

A right leading of irrigation regime (through maintaining the soil water reserve between easily available water content and field capacity on irrigation depth), the application of melioration crop rotation and a organo-mineral system of fertilization for irrigated crops determined the realization of structured degree of 35.98 %, with 3 % bigger than structured degree determined in wheat- maize rotation. In unirrigated melioration crop rotation the structured degree (47,52 %) was bigger than the wheat – maize crop rotation with 34 % (table 1).

Table 1. The influence of the melioration crop rotation and irrigation on macrostructure stability of the preluvosoil, Oradea 1976-2014

Nr. crt	Crop rotation	Ø 5 mm		Ø 2 mm		Ø 1 mm		Ø 0.25 mm		Σ	
		Agreg %	Dif. %	Agreg %	Dif. %	Agreg %	Dif. %	Agreg %	Dif. %	Agreg %	Dif. %
1	Wheat-maize unirrigated	1.93	100	1.76	100	2.45	100	29.12	100	35.26	100
2	Melioration unirrigated	3.93	204	0.96	55	1.96	80	40.67	139	47.52	134
3	Melioration irrigated	0.56	29	0.63	36	1.12	48	33.42	114	35.98	103

The influence on microclimate

The irrigation determined the improve of microclimate conditions. The value of report water/temperature + light (Domuţa Climate Index, ICD) calculated for irrigated maize crop was bigger with 135 % in August, 115 % in July, 49 % in June and 32 % in May. In irrigated maize, the microclimate was characterized "median wet" vs "median droughty" in May, "wet II" vs "median wet" in June, "wet III" vs "median droughty" in July, "wet I" vs "droughty" in August (table 2).

Table 2 The modifications of the water/temperature + light report (Domuţa Climate Index) under the influence of the irrigation in maize crop, Oradea 1976-2014

Variant	V		VI		VII		VIII	
	ICD	%	ICD	%	ICD	%	ICD	%
Unirrigated	8.9	100	10.7	100	8.6	100	6.3	100
Irrigated	11.8	132	15.91	149	18.5	215	14.8	235
Variation interval of differences	0-383		0-302		0-795		28-3126	

The irrigation influence on water consumption

The irrigation determined the increase of the values of daily water consumption. In this case the total water consumption had values bigger than total water consumption of unirrigated crops, the differences was registered between 36.6 % (wheat) and 108.4 % (maize for silo double crop).The most important part from total water consumption was covered with rainfalls registered in the period of the vegetation crops. For the assurance of optimum water consumption of these crops (maintaining the water reserve below easily available water content anf field capacity) the irrigation was necessary every year; the participation averages in the covering sources have values between 33.7 % (wheat) and 58.7 % (maize for silo double crop); the maximum values of the variation interval were registered between 61.0 % (maize) and 103.2 % (maize for silo double crop).

The irrigation influence on yields level

The average of the yields obtained during 1976-2014 in irrigation conditions were bigger than in unirrigated conditions. The relative differences registered had the values between 39 % (wheat) and 127 % (maize for silo double crop).The amplitude of the variation interval for yield differences between two variants was 104 % at sunflower, 116 % at wheat crop, 176 % alfalfa crop 2nd year, 218 % sugarbeet crop, 291 % at alfalfa 1st year, 353 % soybean, 358 % at potato, 800 % at bean, 806 % maize for corn and 25745 % at maize for silo double crop (table 3).

Table 3. The level of yields in main crop, in irrigated and unirrigated conditions, Oradea 1976-2014

Crop	Variant	Yield level			
		Average		Variation interval	
		kg/ha	%	kg/ha	%
1.Wheat	Unirrigated	4547	100	2736-7100	100
	Irrigated	6343	139	3993-8300	105-221
2.Maize	Unirrigated	6608	100	1510-12600	100
	Irrigated	11993	181	17880-16480	107-912
3.Soybean	Unirrigated	1836	100	300-3400	100
	Irrigated	3087	168	1380-4080	107-460
4.Bean	Unirrigated	1439	100	180-2720	100
	Irrigated	2170	151	1321-3770	105-905
5. Sun flower	Unirrigated	2289	100	1350-3140	100
	Irrigated	3394	148	1757-4580	106-210
6.Sugar beet	Unirrigated	39895	100	18960-80900	100
	Irrigated	64453	162	44850-87800	109-327
7.Potato	Unirrigated	24137	100	11500-43700	100
	Irrigated	38284	159	20670-66050	106-464
8. Alfalfa 1st year	Unirrigated	45472	100	18500-89800	100
	Irrigated	69905	154	30500-120850	113-404
9. Alfalfa 2nd year	Unirrigated	60953	100	29500-118590	100
	Irrigated	96822	159	57000-145420	119-295
10. Maize for silo 2nd crop	Unirrigated	13890	100	0-31000	100
	Irrigated	31470	227	10160-44640	115-25860

The influence of irrigation on yield stability

The quantification of the yield stability was made using the “standard deviation ” indicator. In the all crops, the irrigation determined the increase of yield stability, the differences between standard deviations for irrigated and unirrigated conditions was 8.7 % (sunflower) and 50.4 % (maize for silo double crop) (table 4).

The influence of irrigation on water use efficiency

Excepting the sunflower crop, in all the crops, the irrigation determined the improve of water use efficiency, for 1 m^3 water consumpted was obtained a bigger quantity of the main yield than unirrigated conditions, the relative differences had medium values between 2 % (wheat) and 25 % (maize for silo double crop), (table 5).

Table 4. Standard deviation in unirrigated and irrigated crops, Oradea 1976-2014

Variant	Crops for grain									
	Wheat		Maize		Sunflower		Soybean		Bean	
	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%
Unirrigated	922	100	3271	100	580	100	814	100	820	100
Irrigated	642	69.6	1879	57.4	530	91.3	547	67.2	680	82.9
Crops for stalk and roots										
Variant	Sugarbeet		Potato		Alfalfa 1st year		Alfalfa 2nd year		Maize for silo 2nd crop	
	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%
Unirrigated	9240	100	9440	100	37950	100	30160	100	9310	100
Irrigated	6920	79.9	5480	58.1	33630	88.6	25720	85.3	4620	49.6

Table 5 Irrigation influence on water use efficiency, Oradea 1976 - 2014

Variant	Crops for grain									
	Wheat		Maize		Sunflower		Soybean		Bean	
	kg/m^3	%	kg/m^3	%	kg/m^3	%	kg/m^3	%	kg/m^3	%
Unirrigated	1.45	100	1.55	100	0.58	100	0.48	100	0.45	100
Irrigated	1.48	102	1.93	125	0.58	100	0.53	110	0.52	115
Crops for stalk and roots										
Variant	Sugarbeet		Potato		Alfalfa 1 st year		Alfalfa 2nd year		Maize for silo double crop	
	kg/m^3	%	kg/m^3	%	kg/m^3	%	kg/m^3	%	kg/m^3	%
Unirrigated	8.64	100	6.35	100	9.71	100	11.94	100	10.08	100
Irrigated	9.22	106.7	7.23	114	10.44	108	12.42	104	10.95	109

Correlations from soil –water- plant- atmosphere system

Over the years the correlations from soil – water – plant- atmosphere system were quantified for all researched crops (Domuţa, 1995, 1997,1999, 2000, 2003, Domuţa et all, 2000). In this paper were presented the correlations at one of important crop in this area which is maize.

An inverse links were quantified between number of days with pedological drought, water reserve below easily available water content and yield, respectively water use efficiency and between number of days with water reserve on irrigation depth below wilting point and yield determined an inverse links, statistically very significantt. Between number of days with water reserve below easily available water content and yield gain obtained using the irrigation was quantified a direct link, statistically very significant.

A direct links, statistically very significant were quantified between microclimate conditions and yield, respectively between water consumption and yield. This correlations sustained the possibility of maize irrigation in this area (table 7).

Table 7. Correlation in the soil – water – plant – atmosphere system in maize, Oradea 1976-2014

Nr. crt.	Correlation	Regression function	Correlation coefficient
Correlation between soil moisture stress and yield			
1	Nr.of days with WR<WP x yield	$y = 601{,}33\ x^{0{,}9047x}$	R = 0,88 ooo
2	Nr. of days with WR<Wea x yield	$y = 158{,}88\ e^{-0{,}0148x}$	R = 0,66 ooo
3	Nr. of days with WR<Wea x WUE	$y = 3{,}5236\ e^{-0{,}0144x}$	R = 0,62 oo
4	Nr. of days with WR<Wea xyield gain	$y = 0{,}0935\ x^{-0{,}0127}$	R = 0,78 xxx
Correlation between microclimate and yield			
5	ICD x yield	$y=-0{,}2931x^2+13{,}57x-21{,}108$	R = 0,88xxx
Correlation between water use efficiency and yield			
6	WUE x yield	$y=-0{,}0004x^2+0{,}6312x128{,}48$	R = 0,77xxx

WR = water reserve on 0-75 cm depth; WP = wilting point; WEA = easily available water content; WUE = water use efficiency; kg/m^3; ICD = Domuţa Climate Index.

CONCLUSIONS

The paper is based on the researches carried out during 1976-2014 in Oradea, in a long term trial at ten different crops.

The presence of irrigation in the components of sustainable agriculture is sustained by following arguments:

- The evolution of soil structure. In the conditions when was used alfalfa as ameliorativ crop rotation, and the fertilization system includes manure the structured degree (35.98 %) was maintaining to the level of the structure degree from crop rotation wheat- maize unirrigated (35.26 %);
- The droughty microclimate of unirrigated crops and the positive influence of the irrigation on water/ temperature + light report (Domuta climate index), the differences obtained in maize crop arriving at 3126 % in August;
- The improve of the crops water consumption; the differences in comparison with unirrigated crops were between 36.6 % (wheat) and 108,4 % (maize for silo double crop). The optimum water consumption can be assured using the irrigation only. This participation in the covering sources was between 33.2 % (sunflower) and 58.7 % (maize for silo double crop).

- The highest level of yields, median differences, were between 39 % (wheat) and 127 % (maize for silo double crop). The maximum values of the variation interval are between 110 % (sunflower) and 25760 (maize for silo double crop).
- The big stability of the yield, standard deviation values were smaller than unirrigated conditions with relative values between 8.7 % (sunflower) and 50.4 % (maize for silo double crop);
- The increasing of water use efficiency with values between 2 % (wheat) and 25 % (maize);

REFERENCES

[1] Budoi Gh., Penescu A., *Agrotehnica*, Ed. Ceres, Bucureşti, (1996)
[2] Brejea R., *Tehnologii de protecţia solurilor*. Editura Universitatii din Oradea, (2014)
[3] Canarache A., *Fizica solurilor agricole*. Editura Ceres, Bucureşti, (1990)
[4] Domuţa C., *Contribuţii la stabilirea consumului de apă al principalelor culturi din Câmpia Crişurilor*, Teza de doctorat. ASAS "Gheorghe Ionescu Şişeşti", Bucureşti, (1995)
[5] Domuţa C. and all., *Researches regarding the crop water requirement in main crop from Western Romania*. Proceed ICID, International Symposium, Brno and Prague, (2001)
[6] Domuţa C., *Oportunitatea irigaţiilor în Câmpia Crişurilor*. Ed. Universităţii din Oradea, (2003)
[7] Domuţa C., *Irigarea culturilor*, Ed. Universităţii din Oradea, (2009)
[8] Domuţa C. (cord), *Irigaţiile în Câmpia Crişurilor*, Ed. Universităţii din Oradea, (2009)
[9] Domuţa Cr., *Cercetări privind influenţa irigaţiei asupra culturilor de porumb, soia şi sfeclă de zahăr în condiţiile Câmpiei Crişurilor*, Universitatea de Ştiinţe Agricole şi Medicină Veterinară Cluj-Napoca, (2010)
[10] Domuţa C., Domuţa Cr., *Irigarea porumbului în Câmpia Crişurilor*, (2010)
[11] Doorembos J. and Kassam A.M., *Yield response to water*, FAO, Rome, (1986)
[12] Doorembos J. and Pruitt W.O., *Crop water requirement FAO*, Rome, (1992)
[13] Grumeza N., Merculiev O., Klepş Cr. şi colab., *Prognoza şi programarea udărilor în sistemele de irigaţii*. Editura Ceres, Bucureşti, (1989)
[14] Guş P. şi colab., Agrotehnica, Editura Risoprint, (1998)
[15] Hera Cr., *Agricultura durabilă performantă*. Ed. Agris-Redacţia revistelor agricole Bucureşti, (1999)
[16] Picu I., *Favorabilitatea regimului precipitaţiilor pentru principalele culturi de câmp în unele zone agricole din România. În vol. 75 de ani de la înfiinţarea Institutului de Cercetări Agrozootehnice a României.*, Ed. Agris Bucureşti, (2003)

GREEN MANURE TECHNOLOGY IN THE CONDITIONS FROM NORH WESTERN ROMANIA

Cornel DOMUŢA [1], Ioana BORZA[2], Cristian DOMUŢA [3]

Abstract. *The paper is based on the research carried out in an experiment placed in 2010, on a soil with 10 % slope at Agricultural Research and Development Station Oradea. The green manure like main crop is 100 %. Like double crop, the green manure will be seeded before 15th Jily. The green manure yield decreased together with the seed datum is later. Both in the first year of the effect, the yields determined in the variant with lupin+oat+rape were bigger than yields obtained in the variant with lupin, pure crop. The same situation was registered concerning the water use efficiency.*

Keywords: Green manure, technology, sustainable agriculture

1. Introduction

The green manure use is very old agricultural practicing. In the midddle of the XX century a lot of research (Eliade et al, 1983) demonstrated the negative influence of the young green manure (due small C/N report) under the soil because the microbiological procceses are intensified and after green manure mineralized too. [18]

Roger 1976, quoted by Eliade Gh et al, 1983 purposed the use of the mixture crop composed by vetch (30-40 kg/ha) +rye (80 kg/ha) +raigras (0-10 kg/ha). The author purposed the use of the rye on the soil with *Agropyron repens*, the use of the rye (50 kg/ha) and rape (5-10 kg/ha) on the soil with *Sinapis arvensis* and *Raphanus raphanistrum.* [18, 21]

Starting by Roger's conclusions, Domuţa C. in 1988 at Pocola and in 1990 at Beiuş and starting in 2000 at Oradea used the mixture crop for green manure composed by lupin+millet+oat, lupin+rye+rape, lupin+oat; the lupin is the most known green manure from Romania and this was the premisa to realize the mixture crop for green. [13, 14, 15, 16, 17]

One of the most important component of the green manure technology is to establish the sowing period because is very important for farmers if the green manure will be seeded in the 1st crop or in the 2nd crop. The effect of the green manure in the 1st and

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2nd year after the harvesting on yield maize and on water use efficiency are studied in this paper.

2. Material and Methods

The experiment placed in 2010 had two factors: organic fertilization and annual fertilization. Organic fertilization included the variants: control, *lupin*; *Lupinus angustifolius* + oat + rape. Annual fertilization included the graduations: N_0P_0, $N_{120}P_{90}$. Number of repetition used: 4; the plot surface: 100 m^2. The green manures, were sowed like 2nd crop in the 15th July, 3rd August and 20th August. The seed rates used were: *Lupinus angustifolius* in pure crop, 200 kg/hectare; *Lupinus angustifolius* in mixture, 100 kg/hectare; oat, 80 kg/hectare; 10 kg/hectare in mixture crop. Green manures were harvestest at the flowering of the *Lupinus angustifolius*; the green manures were maintained on the soil surface 15 days and after that a ploughland was made.

Water use efficiency was calculated reporting the yield with water consumption. The water consumption was determined by soil water balance based on direct determination of the moisture. Water balance depth used was 0-150 cm. [8,9]

3. Results and Disscusions

Green manure technology sowing data

At the sowing data of the green manure, on 0-25 depth, soil water reserve was over the easily available water content (in 15th July) was a little bellow this parameter (in 3rd August), or a deficit of the soil moisture was registered. In the first stage, after 2 days, the rainfall of 8.4 mm were registered; in the next stages, the first rainfall after sowing were registered after 7 days (30.7 mm) and 8 days (3.0 mm, insignificant). The rainfall registered during the vegetation periods of the green manure were much bigger than multi annual average for these periods; the differences were of 78.2 % for first stage, 86.9 % for second stage and 65.8 % for last sowing stage. (Table 1).

Table 1. The analisys of the conditions registered at the green manure sowing, Oradea 2010

Sowing data	Soil water reserve analisys					Number of days to 1st rainfall	1st rainfall (mm)	Total rainfall during the vegetation period (mm)	
	WR (m^3/ha)	Wea		WP				2010	Multianual average
		(m^3/ha)	%	(m^3/ha)	%				
15.07	774	+111	+17	+439	131	2	8.4	271.0	152.1
03.08	576	-87	-13	+241	71	7	30.7	218.3	116.8
20.08	461	-202	-30	+126	37	8	3.0	161.8	97.6

WR-Soil water reserve (on 0-25 cm depth);

Wea- Easily available water content;

WP- Wilting point;

Yields of the green manures

The very favorable regime of the rainfall determined to obtain the big yields of green manure in the first and second stage of the sowing and good yields in the third stage. The variance analysis emphasized that in the other type of the green manure were obtained the yield smaller than in *Lupinus angustifolius*, pure crop; the exception is the mixture *Lupinus angustifolius*- oat- rape. In the average on the 6 green manure types, the sowing datum of 20 August determined a yield decrease, very significant; the differences were of - 44 % in comparison with sowing datum of 15.07 and of – 41 % in comparison with sowing datum of 3th July. (Table 2).

Table 2. The influence of the sowing datum on green manure yield, t/ha, Oradea 2010

Sowing datum	Green manure variant		The average of the sowing period
	Lupinus angustifolius	*Lupinus angustifolius* +oat + rape	
15.07	41.0	28.7	41.05
03.07	41.3	33.6	39.65
20.08	29.6	18.6	23.00
The average on the variant	37.3^{Mt}	27.00^{000}	-

	Sowing datum	Green manure variant	Green manure variant x sowing datum	Sowing datum x Green manure variant
LSD 5 %	4.20	2.30	2.92	7.28
LSD 1 %	5.62	3.49	4.83	9.74
LSD 0.1 %	7.36	5.60	6.95	12.74

Maize yields the first year of the organic fertilizer effect

In the variant with pure crop of *Lupinus angustifolius*, in comparison with the control, the yields gains were of 499 kg/hectare for first sowing stage of the green manure, 396 kg/hectare for second sowing stage and 380 kg/hectare for third sowing stage. In the *Lupinus angustifolius* mixture the yield gains were bigger than yield gain obtained in *Lupinus angustifolius* pure crop.

Only annual fertilization with $N_{120}P_{90}$ determined to obtain an yield gain of 28 % (1360 kg/ha). (Table 3)

Maize yield in the second year of the organic fertilizer effect

In the second year of the organic fertilization effects, the level of the maize yields were lower because the rainfall registered during the maize vegetation period were of 194.9 mm in comparison with 296 mm in the first year of the effect; the rainfall distribution in the first year of the effect was better, too.

In the variant with *Lupinus angustifolius* without annual fertilization, the differences in comparison with the control were of 273 kg/hectare for first sowing period of the green manure, 374 kg/hectare for second sowing period and of 133 kg/hectare for third sowing period of the green manure.

In the variants with mixture of *Lupinus angustifolius* the difference obtained in comparison with control was bigger than *Lupinus angustifolius* pure crop.

Annual chemical fertilization of the organic variant determined to obtain the maize yield gain bigger than maize yield gain obtained in the variant with organic fertilization only. The yield gains were of 67 % in the variant with *Lupinus angustifolius* + oat + rape. (Table 3)

Table 3. The influence of the fertilization with green manure second crop (15.07.2010) on maize yield (q/ha) 1st and 2nd year of effect, in the conditions from Oradea, Romania

Green manure type	Annual fertilization				Average on green manure fertilization	
	N_0P_0		$N_{120}P_{90}$			
	V_1	V_2	V_1	V_2	V_1	V_2
1. Control	4695	3073	6055	4210	5375	3642
2. *Lupinus* sp	5185	3345	6585	4620	5885	3982
3. *Lupinus* sp + oat + rape	5760	3832	7195	5140	6478	4486
Average on annual fertilization	5213	3417	6612	6060	-	-

V_1-1st year of the effect

V_2-2nd year of the effect

Factor A: green manure type

Factor B: annual fertilization

	A		B		B X A		A X B	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
LSD 5 %	140	210	76	150	155	248	197	324

The influence of the green manures and chemical fertilizers on water use efficiency

The green manure use determined the improve of the water use efficiency in comparison with control both first year of the effect and second year of the effect.

Organic fertilization with manure and green manure associated with annual fertilization with $N_{120}P_{90}$ gave the biggest values of the water use efficiency. In comparison with control fertilized with $N_{120}P_{90}$ only, in the first year, the differences were between 5 % (in rape) and 31 % (manure 50 t/hectare) and in the second year the differences were between 9% and 43 % (in the rape and manure 50 t/hectare). (Table 4)

Table 4. The influence of the fertilization with manure on water use efficiency on maize crop in the conditions from Oradea, Romania

Green manure type	Annual fertilization							
	N_0P_0				$N_{120}P_{90}$			
	V_1		V_2		V_1		V_2	
	kg/m^3	%	kg/m^3	%	kg/m^3	%	kg/m^3	%
1. Control	1.11	100	0.89	100	1.44	100	1.22	100
2. *Lupinus* sp	1.23	111	0.97	109	1.56	108	1.34	109
3. *Lupinus* sp + oat + rape	1.37	123	1.11	125	1.71	119	1.49	122

V_1-1st year of the effect

V_2-2nd year of the effect

CONCLUSIONS

The research carried out in an experiment placed in 2010 at Agricultural Research and Development Station Oradea and there are the following conclusions:

- the green manure were seeded like second crop in 2010 and the first rainfall was registered 2 days after seeding in 15th July, 8 days after seeding in 3rd July and 8th days after seeding in 20th August. The rainfall registered during the green manure vegetation period were bigger than multiannual average: 271.0 mm vs. 152.1 mm; 218.3 mm vs 116.8 mm; 161.8 mm vs 97.6 mm;the biggest quantities of the green manure were registered seeding in 15th July; the maize yields determined in the first and second year of the green manure fertilization effect show the bigger yields in the variants with *Lupinus angustifolius*+oat+rape in comparison with the yields obtained in the variant with Lupinus angustifolius pure crop both in the variants with N_0P_0 and in the variants with $N_{120}P_{90}$.
- the smallest yields were determined in the control. Both in the variant with N_0P_0 and in the variant with $N_{120}P_{90}$ the smallest quantity of maize yield obtained for 1 m^3 water used was obtained in the variant without organic fertilization both in the first year and in the second year.

In the second crop the seeding data will be before 15th July because after that, the quantity and regime of the rainfall don't provide the assurance of the green manure yields.

References

[1] Berca M., 2011, Agrotehnica-transformarea modernă a agriculturii. Editura Ceres, 2004.
[2] Berca M., 2011, Agrotehnica-transformarea modernă a agriculturii. Editura Ceres, 2004.
[3] Bogdan Ileana, Guş P., Rusu T., 2003, Agrotehnica diferenţiată, Editura Risoprint, Cluj-Napoca.
[4] Borlan Z. şi colab, 1994, Fertilitatea şi fetilizarea solurilor (compendiu de agrochimie). Editura Ceres Bucureşti.
[5] Brejea R., 2009, Tehnologii de protecţie sau refacere a solurilor. Editura Universităţii din Oradea
[6] Brejea R, 2010, Ştiinţa solului – îndrumător de lucrări practice, Editura Universităţii din Oradea.
[7] Brejea R, 2011, Practicum de pedologie, Editura Universităţii din Oradea.
[8] Brejea R . 2011 Practicum de Tehnologii de Protecţie a Solurilor. Editura Universităţii din Oradea
[9] Budoi Gh., Penescu A., 1996, Agrotehnică, Ed. Ceres, Bucureşti.
[10] Canarache A., 1990, Fizica solurilor agricole. Ed. Ceres, Bucureşti.
[11] Ciobanu Gh., 2003, Agrochimie. Editura Universităţii din Oradea.
[12] Ciobanu Gh., 2011, Practicum de agrochimie, Editura Universităţii din Oradea.
[13] Domuţa C. et al., 2004, Research regarding the green manure technology and the influences in maize yield in the contest of the sustainable agriculture practising in Western Romania, 15th International Symposium of the International Scientific Center of Fertilizers (CIEC), Pretoria, South Africa, 27-30 September.
[14] Domuţa C., 2005, Agrotehnica terenurilor în pantă din nord-vestul României, Editura Universităţii din Oradea.
[15] Domuţa C. et al., 2007, Influence of crop rotation and green manure on wheat yield in the conditions of the eroded soils of Bihor (Romania), Analele USAMVB Timisoara, Lucrări ştiinţifice Facultatea de Agricultura, vol. XXXIX, Editura Agroprint, Timisoara.
[16] Domuţa C., Brejea R., 2010, Eroziunea terenurilor în pantă din nord-vestul României, Editura Universităţii din Oradea.
[17] Domuţa C., Brejea R., 2011, Eroziunea terenurilor în panta din Bihor, Editura Universităţii din Oradea.
[18] Eliade Gh., Ghinea L., Ştefanic Gh., 1983, Bazele biologice ale fertilităţii solului, Ed. Ceres, Bucureşti.
[19] Guş P. et al., 1998, Agrotehnica, Editura Risoprint, Cluj-Napoca.
[20] Jităreanu G., 1995, Ingineria conservării solului şi apei. Curs. Ed. Univ. Agronomice şi de Medicină Veterinară, Iaşi.
[21] Neamţu T., 1996, Ecologie, eroziune şi agrotehnică experimentală, Editura Ceres, Bucureşti.
[22] Samuel A.D., 2003, Evaluarea microbiologică şi enzimologică a efectelor tehnologiilor agricole asupra biologiei solului. Editura Universităţii din Oradea
[23] Samuel A.D., Drăgan-Bularda M., Domuţa C., 2006, The effect of green manure on enzymatic activities in a brown luvic soil, Studia Universitatis Babeş-Bolyai, Biologia, LI, 1.
[24] Samuel A.D., 2009, Influence of long term fertilization on soil enzyme activities. Analele Universităţii din Oradea, Fascicula Biologie, Tom. XVI, pp. 113-116.

LAND RECLAMATION IN MOLDAVIA. PAST, PRESENT AND FUTURE

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Abstract: *At the end of World War II, Romania's land reclamation area - irrigation, drainage and soil erosion control works - was among the smallest relative to the actual needs of the country. This was despite the fact that landslides, floods, and especially droughts caused large, sometimes catastrophic damage. The yield losses caused by drought, floods, soil erosion triggered famine and human habitat destruction in all regions. During 1950-1989, there were successively developed extensive land reclamation programs reducing the backwardness of the country in this field. This paper analyzes the operation of the land reclamation during the transition to a market economy (after 1990), in the historic province of Moldavia, where, at the end of 1989, over 332 thousand ha were equipped for irrigation, 239.3 thousand ha were equipped against excessive moisture, and 798.2 thousand ha were equipped by soil erosion control works. We have also analyzed the state of the irrigation facilities, in particular. The actually irrigated areas in recent years; represents a little more than 12% of the existing potential in 1989. This paper also examines the causes that led to the disastrous state of the land reclamation, especially as far as the land equipped for irrigation in the province of Moldavia is concerned.*

Keywords: land reclamation; Moldavia; operation, rehabilitation

Among the historical Romanian provinces, Moldavia was apparently the most affected by natural phenomena, with the most serious consequences on the population and on households. Flash floods, floods, but especially droughts caused not only damage but also famine.

The Moldavian chroniclers of the Middle Ages describe the effects of such droughts. Grigore Ureche describes the effects of the exceptional drought from 1585, when *all springs dried up and all fruit perished*, and Miron Costin describes the one in 1660, *when people ate dry rush instead of bread and, therefore, Ştefănită Vodă was named Papură Vodă (in English, the Rush Prince)*.

In more recent times, documentary sources mention that the great droughts that affected large areas took place in 1847, 1866, 1896, 1907, 1945-1946, which inspired the work entitled *Moartea căprioarei* (*The Deer's Death*) to the famous poet Nicolae Labiş.

Since the last decade of the nineteenth century, the irrigations have ceased to be just history and become a problem dealt with increasingly more by policymakers and researchers. Thus, in 1893, the engineer C. Chiru published the paper entitled

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Canalizarea râurilor şi irigaţiuni (*The Sewerage of Rivers and Irrigations*), and, in 1907, the engineer V. Rosu received the Romanian Academy Award for his work entitled *Studiii asupra irigatiilor din România* (*Studies on the Irrigations in Romania*), which took into consideration an area of 150,000 ha in Oltenia, Muntenia and Moldavia, using the inner rivers as water source.

A special committee functioned permanently within the ministry, studying the issue of irrigations and impoundage, but, at the end of the Second World War, in Romania, 20,000 ha were irrigated, especially with vegetables and some with rice.

Floods and flash floods also created problems, especially since Moldavia was famous for the great number of fishing ponds (about 1500, with a total area of around 20,000 ha). However, the stews and ponds favored the production of floods, such as those in 1504 or 1659, which drowned several villages. Nevertheless, in this situation, the rulers recommended or even ordered that residents themselves drain the ponds. In the nineteenth century, there were mentioned flood control works and wetland reclamations, and Caragia's *Codex* (1817-1818) and the *Organic Regulation* (1834) mentioned the need to regulate rivers and drain moors.

With respect to soil erosion, the high agro-terraces from mountainous and sub-mountainous areas were known since ancient times, both in and outside the inner Carpathian chain, in Transylvania and Bucovina [1].

In 1983, there was launched *The National Program to ensure safe and stable agricultural yields by increasing the land's productive potential, a better organization and use of the agricultural land and of the entire surface of the country, in a uniform manner, equipping about 55-60 % of the arable land for irrigation, works of drainage and of soil erosion control*. [2] These areas were to be equipped by the end of 1989. In reality, only 3,067 thousand ha (55.8 %) were equipped for irrigation, draining was performed on 3,107 thousand ha (56.2 %) and soil erosion control works - on 2,200 thousand ha (41.5 %).

<u>Land reclamation</u>. According to the last program, in Moldavia, the following areas were scheduled for land reclamation works: 794,500 ha for irrigation, 340,300 ha for drainage and 932,200 ha for soil erosion control work.

What has been achieved before the end of 1989, compared to the program, is shown below (Table 1).

Compared with the schedule figures, the irrigation works were the lowest, being achieved only in proportion of 41.8 %, with variations between 62.6 % in Galaţi county and 11.5 % in Suceava county. One explanation could be that the investment per unit area in the last years reached 40-50 thousand lei/ ha, while the investments for equipping one ha against excessive moisture or soil erosion was of about 2.5 or less per unit area (ha).

Compared with the schedule figures, the irrigation works were the lowest, being achieved only in proportion of 41.8 %, with variations between 62.6 % in Galati county and 11.5 % in Suceava county. One explanation could be that the investment per unit area in the last years reached 40-50 thousand lei/ ha, while the investments for equipping one ha against excessive moisture or soil erosion was of about 2.5 or less per unit area (ha).

Table 1. Areas scheduled for, and equipped by land reclamation works in Moldavia, by the end of 1989

No	*County*	*Irigations*			*Drainage*			*Soil erosion control works*		
		Programme	*Achieved*	*%*	*Programme*	*Achieved*	*%*	*Programme*	*Achieved*	*%*
1.	Bacău	43200	24000	55,6	8200	3217	39,2	140900	103355	73,4
2.	Botosani	123200	24700	20,0	12400	9875	79,6	84400	95016	112,5
3.	Galati	231700	145100	62,6	71500	49060	68,6	174500	154378	88,5
4.	Iasi	112400	53000	47,2	49300	36111	73,2	153200	103582	67,6
5.	Neamt	18500	10500	56,7	14500	10032	69,2	34400	35048	101,9
6.	Suceava	39100	4500	11,5	69400	43194	62,2	98100	81064	82,6
7.	Vaslui	49700	30400	61,2	59800	39260	65,7	190500	179135	94,0
8.	Vrancea	176700	39900	22,6	55200	48531	87,9	56200	46651	83,0
9.	*Total*	*794500*	*332100*	*41,8*	*340300*	*239286*	*70,3*	*932200*	*798229*	*85,6*

The relatively high achievement degree of the drainage program is due to the fact many areas equipped for irrigation also need works to combat excessive moisture, especially in spring and autumn. The large share of soil erosion control works, sometimes over the program share, is also explained. Radical works, such as terracing, are few; the largest share belongs to simple works, such as drawing ditches somehow on the level curves, on pastures, with the three furrows plow pulled by the tractor. Moreover, we must not forget that only the hydro-improvement works are confirmed by the national statistical system; therefore, taking into account the customs of the era, some land reclamation works have existed only on paper, and even for the hydro-improvement works, there are exaggerated reports, such as 3532.6 thousand ha for the end of 1988 [3].

The main features of the irrigation systems in Moldavia. Compared with most of the irrigation systems from Romania, the hydro-improvement works from Moldavia are distinguished by some special features. Among these, the most important are:

a) *Size.* In a reference system, where the equipped areas exceeding 500 ha are considered large systems, it can be said that everything that was built in Romania falls under the *giant* category. By this criterion, only one system is *very large*, i.e. Covurlui Plain, with an area of 91,342 ha; other six systems have surfaces between 10 and 25 thousand ha (middle category) and another 4 are *small* systems, with areas smaller than 10 thousand ha.

b) *Electricity consumption*. It is an important criterion in assessing the irrigation costs, since the electricity necessary in order to pump, transport and administer the water to plants accounts for over 60 % of total irrigation expenditure. In turn, the electricity consumption is directly dependent on the overall height of water pumping. The English Company *BINNIE-PARTNER and HUNTING TECHNICAL SERVICES LTD,* which studied more than 100 irrigation systems in Romania, concluded that the maximum pumping height for a profitable irrigation is 70 m. This company classified the irrigation systems in Romania according to their energy consumption per ha in four levels: low consumption: below 700 kWh/ha; average consumption: between 700-1400 kWh/ha; medium-high consumption: between 1400-2100 kWh/ha and high consumption: over 2,100 kWh/ ha [6].

According to this classification, the grouping of the irrigation systems in Moldavia is the following:

- Low consumption: less than 700 kWh/ ha .... 52,098 ha .... 19.9 %
- Average consumption: 700-1400 kWh/ ha .... 62,603 ha .... 23.9 %
- Medium-high consumption: 1400-2100 kWh/ ha .... 140,161 ha .... 53.6 %
- High consumption: more than 2100 kWh/ ha .... 6816 ha .... 2.6 %

Total ..... 261,678 ha .... 100.0 %

The national low consumption average accounts for 10%, the average consumption - 28.6 %, the medium-high consumption - 48.2 % and high consumption - 13.2 %.

c) *Irrigation standards*. In terms of the national average irrigation standard of 2,100 cubic meters/ha, the irrigation systems, averaged over the 8 counties, are classified as follows: Galaţi county – 2,400 cubic meters/ha; Bacău, Vaslui and Vrancea - 1,500 cubic meters/ha; Botoşani county – 1,200 cubic meters/ha; Iaşi – 1,100 cubic meters/ha; Neamţ and Suceava counties – 1,000 cubic meters/ha.

d) *Water sources*. The Danube supplies 112,144 ha, i.e. 42.3 %, of Covurlui Plain. Siret River provides the water for 79,688 ha (30.0 %) and Prut River – for 73,561 ha, i.e. 27.7 %.

e) *Design features*. The parliamentary commission, which had assessed the situation of the irrigation systems and of other land reclamation areas, established, in 2009, the following: Although, at the respective time, the constructive solutions were considered in step with the time, many components to the projects have not been completed, such as:

- the impermeabilization of the open canals for water supply and transport, on about 50% of their length, the water losses being considerable;
- the non-performance of drainage (there are recorded only 200 thousand ha) and water circulation systems, with negative effects on large areas – sloughing and secondary salinization;
- the lack of the automation elements for water distribution, as well as of those for water measurement (to this day, not even one m3 of water has passed through a water meter), which led to uncontrolled water consumption, random irrigation and watering standards, high costs;
- the use of poor quality materials, equipment and aggregates that ensured an overall efficiency of water use which did not exceed 50%, compared to the projected share of 83 % [8].

The same deficiencies have been reported since 1991 by a governmental commission established in order to analyze and solve the problems related to land reclamation works: *The works have been carried out since 1966 in irrational rhythms; in the last 15 years, the expansion of the irrigated areas has been pursued in particular, in some cases, giving up the technical requirements in conception and execution and the environmental protection requirements. The canals are unlined on about 40 % of their length, the losses reaching 30-60 %, the yield of the pumping aggregates is below the catalogue values, the watering equipment have low reliability, others are technically outdated... The equipment for soil erosion control, the most necessary among all land reclamation works, were left behind, have not been operated and maintained properly due to the lack of interest of the former Agricultural Cooperatives and of the People's Councils, and due to the lack of money for the agropedological improvement measures* *and to the lack of money for the implementation of the agropedological improvement measures [5].*

The operation of the Irrigation systems. The main parameter that expresses the use of the areas equipped for irrigation is represented by the actually irrigated area reported to the entire area equipped for irrigation (table 2).

Real or not, the areas irrigated in 1990 (when the state agricultural enterprises and the agricultural cooperatives still existed) were close to the areas equipped for irrigation in 1989. The share of the areas irrigated at least once was 82.8 %.

On the other hand, in the period analyzed by the parliamentary investigation [8], the irrigated area was much smaller: 5.6 % in 2006; 17.3 % in 2007; 11.4 % in 2008 and 12.5 % in 2009, per all the irrigation systems in Moldavia.

Table 2. The effectively irrigated areas compared with the areas equipped for irrigation in 1989, period 2006-2009

No.	*County*	*Equipped 1989 (ha)*	*Irrigated 1990 (ha)*	*Equipped 2009 (ha)*	*Irrigated (ha)*			
					2006	*2007*	*2008*	*2009*
1.	Bacău	24000	12044	22854	121	1296	420	665
2.	Botoșani	24700	16803	19819	0	300	0	304
3.	Galaţi	145100	121482	139286	16035	43266	30519	29692
4.	Iași	53000	50543	48934	106	2144	1259	1470
5.	Neamţ	10500	9444	4232	0	0	0	0
6.	Suceava	4500	3864	3454	0	0	0	0
7.	Vaslui	30400	25083	29662	415	4343	1404	4714
8.	Vrancea	39900	35772	30296	0	150	300	340
	Total Moldova	332100	275035	298537	16677	51499	33902	37185
The share of the irigated areas %			82,8		5,6	17,3	11,4	12,5

According to the analysis conducted by the Parliamentary Committee in 2009, the main causes that led to the significant reduction of the irrigated area are the following:

• The dissolution of the large operating structures of agricultural cooperatives, in the beginning due to Law no.18/1991 on the land fund and, then, to Law no.1/2000;

• The degradation of the hydro-improvement infrastructure, triggered by destruction, theft, disrepair, abandonment, lack of interest from the new land owners who had benefitted from re-allotment. This was also accompanied by the inability of the decision makers and of governing authorities to manage and organize the exploitation of an important agricultural heritage and, at the same time, of the national economy.

• The progressively increasing charges for the irrigation water and, especially, the differentiation of the pumping speed levels also contributed to the reduced interest in irrigation;

• The destruction of the electricity transmission network, together with the disconnection of the power supply network and its partial dismantling (extraction of transformers), motivated by its inactivity;

• The lack of conviction of many landowners of the economic benefits brought by the agriculture under irrigation, associated with the delay in setting up IWUA/IWUO (Irrigation Water Users Association/ Irrigation Water Users Organization);

• The shortage of the equipment for the administration of water to plants;

• The mismatch between the activities conducted for the rehabilitation of the irrigation infrastructure and the actual water demand, at the level of the hydro-technical system;

• The uncertainty on the selling market regarding the breeds that respond best to irrigation, such as maize or vegetables, in terms of a very permissive policy as far as the imports are concerned.

It also considered that one of the main reasons of the low irrigation rates is represented by the deficiencies in the watering equipment, which results from the data submitted by branches. It is noteworthy that, in some areas – in southern Moldavia, for example – there were established IWUAs (Irrigation Water Users Associations) on areas larger than those reported functional in 2009. The actually irrigated areas are instead much smaller than the contracted ones.

Across counties, the area actually irrigated in 2009 is smaller than the one that might have been irrigated with the existing equipment and much smaller than the contracted area, resulting in a significant shortage of the watering equipment.

Regarding the drainage works, the Commission concludes that they were neglected and that, in case of natural disasters, they would not cope. Causes: Lack of funding and the disorganization produced by Law no. 138/2004, which separated ANIF (National Agency of Land Reclamation) and SNIF (National Society of Land Reclamation), depriving the latter of the specialized personnel and of the necessary equipment.

In connection to the soil erosion control works, the situation is similar. The commission accused the way in which the restitution of land was applied under Law no.18/1991, i.e. in the hill-valley direction, which favored erosion. The issue of the maintenance or restoration works is complicated by the fact that both actions need both the current owners' agreement and contribution.

Studies for the rehabilitation of the irrigation systems in Moldavia. The report drafted by the governmental commission in 1991 [5] reveals that not less than 787 land reclamation works were under execution, of nearly 105 billion lei. The authorities had to decide what to resume, what to cease, and what to keep. Therefore, the rehabilitation studies began.

The first study was conducted by the English company BINNIE-PARTNER and HUNTING TECHNICAL SERVICES LTD, in collaboration with ISDLR (the Institute for Study and Design for Land Reclamation, Bucharest). It was concluded that the limit of the irrigation economic efficiency is where the extra profit obtained by irrigation intersects with the additional irrigation expenditures. In turn, these expenditures are heavily influenced by the consumption of the electricity needed to pump water and, thus, by the pumping height. There was drawn a scale of the economical viability of the areas equipped for irrigation, according to the water pumping height (Table 3).

Table 3. The economic viability of the irrigated area according to the pumping height, in connection to the source

No.	*Hg (m)*	*Area equipped for irrigation (million ha)*	*Economic viability*
1	0-10	0,50	Exceptional
2	10-30	0,25	Very good
3	30-45	0,25	Good
4	45-55	0,25	Satisfying
5	55-65	0,25	Satisfying/ Unsatisfying
6	65-90	0,60	Unsatisfying
7	> 90	1,00	Disastrous !

Source: Study of Irrigation and Drainage in Romania (1992-1994)

This limit is reached somewhere at pumping heights greater than 70 m. All the systems included in this study were classified according to this criterion (104 in number). There was also drafted a map where all irrigation systems (or parts of the system) whose pumping height was over 70 m were marked on the legend.

In Moldavia, 16 irrigation systems have been analyzed, and it was found that the following have heights of over 70 m: Cămărăsesti-Aval, Horia-Liveni and Ripiceni-Rock (Botoşani county); Racova-Filipeşti (Bacău county) and Covurlui Plain, with an area of 100 thousand ha (Galaţi county). It is should be mentioned that, according to the BINNIE study, in perspective, in Romania, maximum 1.3-1.5 million ha would be economically irrigated.

A second study for the rehabilitation of the irrigation systems was conducted by the Japanese company JICA (Japan International Cooperation Agency) in 1994-1995 [7]. It studied an area of 22,360 ha in Vrancea county, which would have been supplied by the water from Calimanesti dam and from Siret-Baragan canal. The extra profit obtained by irrigation was estimated at 12.2 %, compared to the previous situation.

A final study on the rehabilitation of the irrigation systems was initiated by MAPDR in 2009 and it was conducted by the Dutch company *Fidman Merk at SRL* [9]. The study entitled *the Project for the Irrigation Sector Rehabilitation and Reform (PRRSI)* was completed in 2011. There were analyzed virtually all Romanian irrigation systems, on an area of 2,965 thousand ha, by different criteria: the current level of use, tariffs for the water supply, IWUO (Irrigation Water Users Organization), the aridity index. These four criteria were given grades and a final score between 10-53 was established. For Moldavia, 8 irrigation systems were studied and proposed for the inclusion in the investment plan (Table 4).

The figures presented in the table above show great differences between the areas equipped for irrigation existing in the NALR (the National Agency of Land Reclamation) heritage and the economically viable ones, but also between the latter and the effectively irrigated areas, although their owners have expressed their intention to irrigate virtually the entire area equipped for irrigation, existing in NALR statistical record.

Table 4. The irrigation systems from Moldavia proposed for the inclusion in the investment plan for the next period, according PRRS1

No.	*Irrigation system*	*County*	*Analyzed area ha*	*Economically viable area ha*	*Area irrigated in 2009 ha*	*Area equipped in IWUO ha*
1	Letea	Bacău	1118	1118	415	1118
2	Dămieneşti	„	2276	2276	192	1381
3	Brateşul de Sus	Galaţi	4116	4116	2769	4136
4	Câmpia Covurlui	„	90920	26363	28381	98233
5	Ţigănești și Perieni	Iaşi	3368	1178	127	3368
6	Terasa Trifeşti-Sculeni	„	17258	13092	1465	3052
7	Albita-Fălciu	Vaslui	16937	16937	4790	15296
8.	Putna	Vrancea	2385	2385	380	2385
	T o t a l		138398	67485	38519	128369

Source: PRRS1 – 2011 Data [9]

The causes that led to this situation are known from the repeated analyzes, studies and surveys conducted in the last 25 years, which also made proposals for the rehabilitation of some areas that, however, do not exceed 50 % of the area statistically equipped at the end of 1989. Nowadays, in Moldavia, very small areas (11,030 ha in the south of the historical province of Terasa Nicoresti Tecuci) were rehabilitated and there are plans to resume the work on Siret-Bărăgan Canal project, which, however, covers only a small part of Moldavia’s needs.

Conclusions

1. We have inherited from the previous political regime of 1990 an impressive amount of land reclamation, more than 3 million ha equipped for irrigation and another 3 million ha equipped for the removal of excessive moisture, and over 2.2 million ha equipped for soil erosion control. Nevertheless, the regime’s ambitions were higher: 5.5 million ha equipped for irrigation; 5.53 million ha equipped for drainage and 5.3 million ha - for soil erosion control.

2. If there is no doubt as far as the necessity of last two categories of works is concerned, the irrigations under Romania’s conditions have given raise to different opinions, especially because the market economy adapted as an economic system changed the situation.

3. The State is not the only master of the country's resources anymore and it can no longer afford discretionary transfers of goods from one economic sector to another. The

investments must be economically profitable not only nationally but also in the economic sector, where they are carried out, especially since the companies that support and exploit them are private and they can not afford to work at a loss.

4. For the correct dimensioning of the irrigation systems, we used foreign companies specialized in this field, some of them mentioned in this paper. The unanimous conclusion was that the size of the irrigation sector should not exceed 1.5 million ha and that the irrigation systems require adaptations to the new operating structures, including at the economic level.

5. NALR went through several reorganizations and, therefore, it became an impediment, since there was inherited a heritage, an institutional structure that no longer has an activity object. On the other hand, the new great estates established on drained land – in an abusive manner, according to several specialists - do not want to abandon the irrigated agriculture system and use dry farming instead, requiring substantial financial support to the state.

6. The trend of the irrigated areas in the last decade demonstrates, however, that even in the next decade there will not be irrigated more than 1.2-1.5 million ha, which will bring Romania to arable shares similar to the ones of the states with similar climatic parameters.

References

[1] Lup A.: *Irigatiile în agricultura României.* (Ed.Agris, Bucureşti, 1997).

[2] x x x: *Programul naţional pentru asigurarea unor producţii sigure şi stabile pentru creşterea potenţialului productiv al pământului, mai buna organizare şi folosire în mod unitar a terenurilor agricole, a întregii suprafeţe a ţării, realizarea irigaţiilor pe circa 55-60 % din suprafaţa arabilă, a lucrărilor de desecări şi combatere a eroziunii solului,* (Bucureşti, 1983)

[3] x x x: *Realizări în domeniul îmbunătăţirilor funciare 1948-1989.* (Ministerul Agriculturii, DGEIFCA Bucureşti, 1989).

[4] x x x: *Anuarul statistic al României* (1990).

[5] x x x: *Raportul Comisiei Guvernamentale pentru analiza şi soluţionarea problemelor legate de lucrările de îmbunătăţiri funciare* (Bucureşti, 1991).

[6] x x x: *Study of Irrigation and Drainage in Romania* (Bucureşti, 1994).

[7] x x x: *The Feasibility Study on the Irrigation Project in Rugineti-Pufeti-Panciu, district Vrancea* (JICA 1995).

[8] x x x: *Raportul Comisiei Parlamentare de anchetă privind situaţia sistemelor de irigaţii, precum şi a altor sectoare de îmbunătăţiri funciare* (Bucureşti, 2009).

[9] x x x: *Proiectul PRS1 – Reabilitarea şi Reforma Sectorului de Irigaţii* (MAPDR, 2011).

[10] x x x: *Dările de seamă AGR1 IF ale DGEIFCA.*

Annals of the Academy of Romanian Scientists
Series on Agriculture, Silviculture and Veterinary Medicine Sciences
Online ISSN 2069 – 1149 Volume 4, Number 1-2/2015 73

THE RAPE CROP PRODUCTION IN ROMANIA, ENERGY RESOURCES AND THE IMPLICATIONS IN THE ECOLOGIC AND ECONOMIC SYSTEM

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Abstract: *In order to ensure a source energy, the rape culture is of particular importance and its unprecedented spread in the world and in our country, in this the work being highlighted the extension of this culture. In the annual dynamics 2007-2013 are rendered the indicators that reveal the production capacities levels, resources and use, finally completed by the trade image. All questions submitted to the national level pursue knowledge/evaluation of the potentialities development of the rape culture, at which were analyzed the economic effects from which it can be defined the extending trends and the restrictive sides in the current stage of the agriculture development.*

Keywords: efficiency indicators, industrial processing, production capacity, supply balance, trade

1. Introduction

The territorial area is increasingly wider for the use of biodiesel in Europe and the USA included also Romania, and which resulted in extending the potential of agriculture by encouraging alternative crops of technical crops, in order to ensure the energy production, includes also the rape culture.

Its importance and unprecedented spread in the world and in our country, highlights this crop area expansion. It can be highlighted the many companies in Western Europe that have embarked on an offensive in the Romanian market. They sought the surfaces expansion on which to cultivate rape, production that later to be transformed into oil and, as a result of additivation to turn into biodiesel.

Through this work in the succession of the annual growth rate 2007-2013 are played indicators that reveals the levels of production capacities, resources and uses, finally completed with the trade.

All questions submitted at national level are aiming at knowledge/evaluation of potentialities for the development of the cultivation of rape crop, at which were

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analyzed the economic effects, from which it can be delineated the expansion trends and the sides of the current restrictive stage of agriculture development.

2. Materials and Methods

The evaluation of the possibilities for development carried out on the basis of the data processing, requires the means of identification of the factors of action involved. This is because it is permanent required the indication of trends generating the future development.

By appropriate analytical methodology, in this paper have been used processing forms whose database had the production of rapeseed in the existent dynamics for the period 2007-2013. The database of completed productions at the national level have been taken from the Yearbook of Romania, INS (2014), which was used also for the purchase prices.

The processes were carried out in accordance with the annual growth rate and the data were structured in a tridimensional form which has followed production capacities, resources/uses and trade.

Data processing was carried out in a suitable form showing representative levels which were playable through percentage comparisons against year 2008, the succession of years past, but also towards the average annual dynamics.

Regarding the expenses, they were estimated cumulative for hectare (classified under the fixed and variable expenses) with playable levels in specialist works [1]. The variation in the amount of production expenses played in this work were set out as follows: the fixed costs due to the equivalence of the level of these expenditures (1,850 lei/ha); variable costs evaluation was made in proportion to the level of the yields achieved annually (183.82 lei/tone).

The supply balance also through indicators, highlighting the annual variations fluctuations of uses and resources. For Export/import indicators were conducted analysis quantitative and value, also existing the possibility of the total values interpretation of the indicators, the comparison to the year 2007, as well as knowledge of the changes from the previous year.

A deepening of the study was based on extrapolation of imports and exports which has been carried out on the basis of the equation of quadratic trend type of the following form:

$Y(UM)) = a1x1^2 + b1x1 + c1$

Where, X1 represents the production achieved. For confidence limits corresponding to a given risk [2] has been used formula, Yajust (+/-ðy · tp), in which:

Y = imports /exports adjusted; ðy = standard deviation; TP = tabular value for probability of transgression (risk).

As such, extrapolating the trend dynamics for import/export for rape, we have the formula: Yadjusted (+/-) ðx ·TP, in which it is defined the upper limit (Yadjustedt + ðx · tp) and the lower limit (Yadjusted-tp ðx).

The amplitude of oscillation of the confidence limits [3] is: (+ tp Yaj ðy) and (ðy Yaj-tp)

The result was that for all import/export: upper limit = Y + 1.86·6 x; adjusted lower limit Y =-1.86·6 x

The results have pursued the extrapolated production for the year 2015, which was calculated as the average of the last 5 years for the period 2010-2014.

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3. Results and disscusions

The analysis carried out at national level was based on a structure in which it is possible to deduce interpretative in the successive stage of the evolution of production capabilities, resources and elements of production and trade.

I-PRODUCTION CAPACITY

Through the cultivation systems of rape culture has been tracked continuously ways and methods to increase yields and the quality of their environmental and within the limits of economic efficiency. At the national level we analyzed the production capacities for the rape culture, with reference to the areas and yields obtained and were recorded along the analyzed period large fluctuations. In *table 1* through the dynamics of the 2008-2013 are played levels and areas of productions, whichwere made through comparisons carried out can be deducted the follows:

- area cultivated with rape can ascertain significant annual variations, but which can be analyzed in the dynamic for two periods: the period 2008-2010 where it finds an increase in cultivated areas and the period 2011-2013 is characterized by a setback (for 2008 represents a maximum of areas cultivated, and 2012 a minimum of - 21.73 % in comparison with 2008);

Table 1. -Surface and yields for the rape culture in Romania

Specification	UM	2008		2009		2010		2011		2012		2013	
		Total	private	Total	private	Total	private	Total	private	Total	private	Total	private
Cultivated surface	**thousand hectares**	365.0	360.5	419.9	415.3	537.3	528.9	392.7	388.5	105.3	103.2	276.6	274.5
	% compared to 2008	100	98.76	115.04	113.78	147.20	144.90	107.58	106.43	28.84	28.27	75.78	75.20
	% compared to previous year	-	98.76	116.47	98.90	129.37	98.43	74.24	98.93	27.10	98.00	268.02	99.24
Total production	**thousand tons**	673.0	663.6	569.6	563.2	943.0	925.9	739.0	730.8	157.5	154.0	666.1	661.1
	% compared to 2008	100	98.60	84.63	83.68	140.11	137.57	109.80	108.58	23.40	22.88	98.97	98.23
	% compared to previous year	-	98.60	85.83	98.87	167.43	98.18	79.81	98.89	21.55	97.77	432.53	99.24
Production per hectare	**kg/ha**	1,844	1,840	1,357	1,356	1,755	1,750	1,882	1,881	1,496	1,492	2,408	2,408
	% compared to 2008	100	99.78	73.59	73.53	95.17	94.90	102.06	102.00	81.12	80.91	130.58	130.58
	% compared to previous year	-	99.78	73.75	99.92	129.42	99.71	107.54	99.94	79.53	99.73	161.39	100

Source: Statistical Yearbook of Romania, INS, 2014 [2]

- the total production offers significant variation in annual levels, and are between 157.5 tons to 943.0 tons, the achievements what are related to 2012 and 2010 respectively. Analyzed comparatively, it may find that compared to base year 2008, these variations are significant while in the same year, the levels are between 22.88 % and 137.57 %;

- yields per hectare, reflect lower levels for oscillation which are between 1,357 kg/ha (2009) and 2,408 kg/ha (2013). It can be observed a rising trend, with interpretative elements over the significant decrease in production in 2009, followed by an increase from 2013.

All of these issues have been pursued through a quantitative analysis, which is why it was necessary to an investigation by knowing the economic efficiency of rape culture. In this context the following is presented the interpretive situation of price levels of production, value of production, costs and gross profit. In *table 2* by absolute values (lei/kg and lei/ha) and relative (percentage comparisons) placed in the dynamics of the period 2008-2013, are rendered the levels within which these indicators as follows:

Table 2. Indicators of efficiency to rape culture in Romania

Specification	UM	2008	2009	2010	2011	2012	2013
Purchase price	lei/kg	1.20	0.97	1.25	1.62	1.83	1.57
compared to 2008	%	100	80.83	104.16	135	152.5	130.83
compared to previous year	%	-	80.83	128.86	129.6	112.96	85.79
The value of production acquisition cost	lei/ha	2,766	1,316.29	2,193.75	3,048.84	2,737.68	3,780.56
compared to 2008	%	100	47.58	79.31	110.22	98.97	136.67
compared to previous year	%	-	47.58	166.66	138.97	89.79	138.09
Estimated production costs *(ch. de Prod. 1850 fixed lei/ha + ch. 0.183 lei/kg variables)	lei/ha	2,188.96	2,099.44	2,172.60	2,195.94	2,124.99	2,292.63
Gross profit	lei/ha	577.04	-783.15	21.15	852.9	612.69	1487.93
compared to 2008	%	100	-135.71	3.66	147.80	106.17	257.85
compared to previous year	%	-	-135.71	270, 06	4,032.62	71.83	242.95

Source: Statistical Yearbook of Romania, INS, 2014; *) Estimated by processing Levels playable after: Pirnă, I., etc., the cultivation of rape, 2011, INMA Bucharest-P2; Top 5 most profitable crops, http://m.business24.ro/macroeconomie/top-5-cele-mai-profitabile-culturi-agricole-1526826. [1, 2, 7]

- the purchase price registered with oscillators levels which has a rise trend, at which in the percentage comparisons compared with 2008 has a maximum increase of + 52.5 %;

- the production value at purchase price, expressed in the unit of surface, indicates annual increases at which, indicator correlated with yields at ha, reflects increases compared to base year 2008, the growth is of + 36.7 %;

- the production costs estimated at production unit [4] (1,850 lei/ha fixed + variable 0.183 lei/kg), outlines the variations that can be considered insignificant;

- as synthetic indicator, the profit for most years indicates favorable values, with a level of annual variations. It may be noted in 2009 a loss is reported (-783.15 lei/ha) and in 2013 with the highest level (lei/ha 2,292.63). The comparisons of percentage for this indicator in the dynamics reflects variations with a peak in 2013 (+257.85 % compared to 2008).

From the structural analysis of economic indicators, it emerges an interaction production -expenses- prices which shows: on the one hand a variation level, and on the other hand the existence of a threshold of profitability in production (referring to 2009, the results of which are entirely unfavorable, and the following year 2010 can be considered to be a limit, i.e. with 21.15 lei/ha, which represents the lowest level of profit).

All of these problems involve the Knowledge of the rape growing capacity of agricultural holdings in Romania. It was considered that these holdings can be analyzed according to the class size of utilized agricultural surface. At the national level for 2007 and 2008 in *table 3* summarizes this structure where you can embrace aspects that can be can be delineated: quantitative and qualitative

Table 3. - The structure of agricultural holdings growing rapeseed in Romania (on class size of utilized agricultural surface)

The structure of the size classes	2007			2008		
	number	% compared to total	percent compared to the average size of classes (12 classes)	number	% compared to total	percent compared to the average size of classes (12 classes)
Total of which:	8,016	100	100% = 668 ha	10,550	100	100% = 879.1667 ha
below 0.1	-	0	-	16	0.15	1.78
0.1-0.3	92	1.15	13.77	90	0.85	10.031
0.3-0.5	-	0	-	81	0.77	9.02
0.5-1	101	1.26	15.11	205	1.94	22.84
1-2	217	2.71	32.48	447	4.24	49.82
2-5	1,438	17.93	215.26	1,409	13.36	157.05
5-10	1,494	18.64	223.65	1,120	10.62	124.83
10-20	730	9.11	109.28	876	8.3	97.64
20-30	258	3.22	38.62	451	4.27	50.26
30-50	698	8.71	104.49	599	5.68	66.76
50-100	411	5.12	61.52	940	8.91	104.77
over 100	2,577	32.15	385.77	4,316	40.91	481.07

Source: Statistical Yearbook of Romania, INS, 2014 [2]

- on the quantitative side you can see that the number of agricultural holdings growing rapeseed is growing, along with the growing average size of holdings which tends to expand the size classes with bigger surfaces (situation reported for both years). 2008 compared with 2007 highlights an amplification for both situations with + 31.61 %;

- the structure of the size classes of holdings considered in qualitative aspect highlights the two-way aspect: is found for holdings with rape culture areas over 2 hectares (these occupying in 2007 more than 95 % of the total surface area); majority of farms are growing for the dimensions of the surfaces of sizes 2-20 ha and 50 - 100 hectares.

From all this it follows that the limits potential yields achieved is offering levels of efficiency. From the analysis of the number of the rape growing farms we see a growing trend, and the size structure of the areas held by the culture of rape is classified at the medium and maximum limits towards.

II.-RESOURCES AND USES

The continuity of such an analysis is given by the knowledge structure of resources and uses of the products of rape culture. The national level within a balance of indicators is presented in the continuation through percentage comparisons within the dynamics of 2007/2009-2012/2013.

The resources in the supply balance sheet for the production of rapeseeds, is played at the national level in *table 4*, where it can be highlighted the following aspects:

Table 4. - Resources in the supply balance sheet for rape crop in Romania.

Specification	UM	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013
A.-Resources	**thousand tons**	367.2	760.2	615.8	972.3	762.2	206.5
	% compared to 2007/2008	100	207.02	167.70	264.78	207.57	56.23
	% compared to previous year	-	207.02	81.00	157.89	78.39	27.09
1.-usable Production	**thousand tons**	361.5	673.0	569.6	943.0	739.0	157.5
	% compared to 2007/2008	100	186.16	157.56	260.85	204.42	43.56
	% compared to previous year	-	186.16	84.63	165.55	78.36	21.31
2.-Imports	**thousand tons**	5.7	87.2	46.2	29.3	23.2	49.0
	% compared with total exports	1.90	13.03	1.90	6.87	5.79	337.93
	% compared to 2007/2008	100	1,529.82	810.52	514.03	407.01	859.64
	% compared to previous year	-	1,529.82	52.98	63.41	79.18	211.20

Source: supply balance sheets for the main agri-food products, 2013, 2014, INS reference period: 1 (previous year) to 30 VI (current year) [3]

- the annual level of resources is very variable, observing an upward trend, finding a maximum in 2010/2011 (being of 972.3 thousand tons), after which the final year 2012/2013 is registered a sharp decrease (206.5 thousand tons). For the same annual percentage comparisons highlight these variations in both the base year 2007/2008, and compared to previous year;

- the usable production volume is majority-against total resources, levels also showing annual variations;

- the imports constitute a complement of resources and with a very small share compared with the total resources. Annual exports compared to imports, means for most years a small share (between 1.9 % and 6.87 %), but a very high proportion of year 2012/2013, usable production (internal) decreased to very low levels.

The existence of all these recent variational levels in sourcing resources involves knowledge of uses structure which in the same period, the growth rate for the national level, appear in *table 5*. The comparisons made by level indicators show the following:

Table 5. – Uses in the total supply balance for rape in Romania.

Specification	UM	2007/2008	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013
B.-USES	**thousand tons**	367.2	760.2	615.8	972.3	762.2	206.5
	% compared to 2007/2008	100	207.02	167.70	264.78	207.57	56.23
	% compared to previous year	-	207.02	81.00	157.89	78.39	27.09
3.-Exports	**thousand tons**	299.3	669.0	2,423.3	426.1	400.6	14.5
	% compared with total imports	5,250.87	767.20	5,245.23	1,454.26	1,726.72	29.59
	% compared to 2007/2008	100	223.52	809.65	142.36	133.84	4.84
	% compared to previous year	-	223.52	362.22	17.58	94.01	3.61
4.-variation of stocks	**thousand tons**	-	-	-	214.5	-1,364	123.8
	% compared to 2007/2008	-	-	-	100	-635.89	57.71
	% compared to previous year	-	-	-	-	-635.89	-9.07
5.-Internal Use	**thousand tons**	67.9	91.2	372.5	331.7	498.0	68.2
	% compared to 2007/2008	100	134.31	548.60	488.51	733.43	100.44
	% compared to previous year	-	134.31	408.44	89.04	150.13	13.69
-seeds	**thousand tons**	2.4	2.9	3.4	4.3	3.1	0.8
	% compared to 2007/2008	100	120.83	141.66	179.16	129.16	33.33
	% compared to previous year	-	120.83	117.24	126.47	72.09	25.80

-animal feed	**thousand tons**	-	-	0.8	0.8	0.1	-
	% compared to 2007/2008	-	-	100	100	12.5	-
	% compared to previous year	-	-	-	100	12.5	-
-loss	**thousand tons**	0.5	0.9	1.4	1.1	1.1	0.1
	% compared to 2007/2008	100	180	280	220	220	20
	% compared to previous year	-	180	155.55	78.57	100	9.09
-industrial processing	**thousand tons**	65.0	87.4	366.9	325.5	493.7	67.3
	% compared to 2007/2008	100	134.46	564.46	500.76	759.53	103.53
	% compared to previous year	-	134.46	419.79	88.71	151.67	13.63

Source: supply balance sheets for the main agri-food products, 2013, 2014, INS reference period: 1 (previous year) to 30 VI (current year) [3]

- in the supply balance is found that total annual uses highlights corresponding variations with resources (are the same annual variational levels);

- the exports analyzed by both comparisons against total imports, but also compared to the base year 2007/2008 highlights higher levels (except for the year 2012/2013 at witch the very usable production recorded very low values);

- the internal usage highlights a growing annual level, to which in the structural analysis an important role lies with industrial processing.

Or all of these presentations of resources and uses highlights, in one side the existence of a preponderance of internal productions, and on the other hand the high level of exports with an industrial processing at the national level.

III.-TRADE

Permanently, the trade knowledge, constitutes an aspect that fills the whole system of circuit capitalization efficiency. The bivalent import/export issues were based on the analysis of the dynamic structure of indicators relating to the quantity and value of production. The comparative presentations that appear in *table 6* seeks to highlight the main aspects of trade, which can be highlighted:

- imports are at a much lower level than the exports side, recorded quite high. Quantitatively by comparison with the base year 2007 growth of imports are significant (analysed quantitatively amplitudes vary between 24.8 and 6.1 times). Similarly, the value analysis showed that imports are much lower than exports (as compared by amplitudes compared to 2007 annual variation is observed between 3.5 and 11.4 times);

- exports analyzed by the same group of indicators are found both quantitatively and in value, a level much higher than the imports. The comparison compared to 2007 found a variation in the level of these exports, but also a growing trend for 2010, followed by a decrease (in 2011 and 2012, in which is found a setback both quantitative as well as in value).

It follows that in the international trade of rape seed and for Romania as it establishes the existence of favorable opportunities especially for export activities, to which the quantities marketed is still reported a variation level. Within this framework the dynamic oscillatory form 2007-2014 has been pursued through the upper limits, adjusted results and lower limits for the extrapolation of imports/exports. It was pursued the value determination by using a function for a variable value located outside the range of known values. These were analyzed quantitatively (thousand tons) and value (million euros) and played in a two-dimensional form: for the year 2015; year 2015 towards the period 2007-2014.

Table 6. - The situation of trade in intra and extra-EU in the period 2007-2012 in Romania

	UM	2007	2008	2009	2010	2011	2012
IMPORTS							
Quantity	tons	9,703.6	76,360.6	70,466.9	241,043.8	70,682.6	59,466.3
	% compared with total exports	3.47	13.53	9.00	22.90	12.24	87.13
	% compared to 2007	100	786.93	726.19	2,484.06	728.41	612.82
	% compared to previous year	-	786.93	92.28	342.06	29.32	84.13
Value	thousand euros	7,902.7	35,816.5	28,158.2	88,108.8	50,203.6	42,826.5
	% compared with total exports	10.16	14.55	12.58	26.37	18.37	102.40
	% compared to 2007	100	453.21	356.31	1,114.92	635.27	541.92
	% compared to previous year	-	453.21	78.61	312.90	56.97	85.30
EXPORTS							
Quantity	tons	279,125.5	564,028.6	782,186.4	1052,366.2	577,206.6	68,246.0
	% compared with total imports	2,876.51	738.63	1,110.00	436.58	816.61	114.76
	% compared to 2007	100	202.06	280.22	377.02	206.79	24.44
	% compared to previous year	-	202.06	138.67	134.54	54.84	11.82
Value	thousand euros	77,720.9	246,035.6	223,703.0	334,038.5	273,270.4	41,819.0
	% compared with total imports	983.47	686.93	794.45	379.12	544.32	97.64
	% compared to 2007	100	316.56	287.82	429.79	351.60	53.80
	% compared to previous year	-	316.56	90.92	149.32	81.80	15.30

Source: ANV and the INS, quoted in the paper Rapeseed Oil, http://www.madr.ro/ro/culturi-de-camp/plante-tehnice/rapita-pentru-ulei.html [5]

The rape imports extrapolation (by expressing in thousands tons and mil euros) based on production (thousands tons) in Romania in *table 7* outlines differentiated aspects that can be rendered as follows:

- analysed quantitatively based on extrapolation of imports in accordance with the function of production adjustment (Yaj (thou to) = $0.000053 \cdot x^2 + 0.03 \cdot x + 26.97$), indicates that the dynamic years differentiations can be considered significant. With reference to annual periods may indicate: a maximum of imports for 2010 and 2014; for the remaining years a decrease to these imports; for year 2015 an average level of imports;

- the analysis of the imports value frames the results of the adjusted function (Y (Mil. euro) = $0.00005 \cdot x^2 - 0.030 \cdot x - 32.777$) which for the levels of the upper/lower limits has annual amplitudes much lower. The very year 2015 levels are set at the lower limit values.

Table 7 – The rape imports extrapolation (thousands to/mil euro) based on production (thousands to) in Romania (year 2015 towards 2007-2014)

The years	Quantity (thousand tonnes) $\sigma x = 6.4$; tp = 1.86 Yaj (thou to)^2 =$0.000053 \cdot x^2 + 0.03 \cdot x + 26.97$			Value (million euro) $\sigma x = 3,64$; tp = 1.86 Y (Mill. euro)^2 = $0.00005 \cdot x^2 - 0.030 \cdot x - 32.777$		
	Limit upper	Adjusted import	Limit lower	Limit upper	Nota t adjusted	Limit lower
2007	65	28.5	16.5	35.2	17.6	13.4
2008	92.2	73.1	33.5	26.0	35.1	17.6
2009	82.1	62.9	43.	38.6	19.8	25
2010	124.1	104.9	53.3	34.5	48.8	26.2
2011	99.3	80.1	61	27.7	23.5	31
2012	52.6	20.8	14.3	36	18.2	14.0
2013	91.5	72.3	53.2	25.8	21.7	17.5
2014	142	122.9	103.7	40.2	58	31.8
2015	96.7	77.6	58.4	27.1	22.9	30

The attached graphs highlight the year 2010 with the highest import, and in the year 2007 the lowest of imports, but by the adjustment highlights an uniform trend of quantities/values played through the respective curves.

In the export activity the quantities and value extrapolation of the production from rapeseed (by expressing in thousands tons and mil euros) based on production (thousands tons) in Romania is illustrated in *table 8* where are similarly highlighted the following aspects:

- the knowledge of the quantitative variations (based on the regression function
Y (thou to) = $0.000053 \cdot x^2 + 0.03 \cdot x + 26.97$), played by upper/lower limits, has annual variations. For mentioning is that years 2010 and 2014 is reported the maximum of exports, the limits were expressed through the dynamic 2007-2015 through a values correlation, but the year 2012 is represented by a negative value;

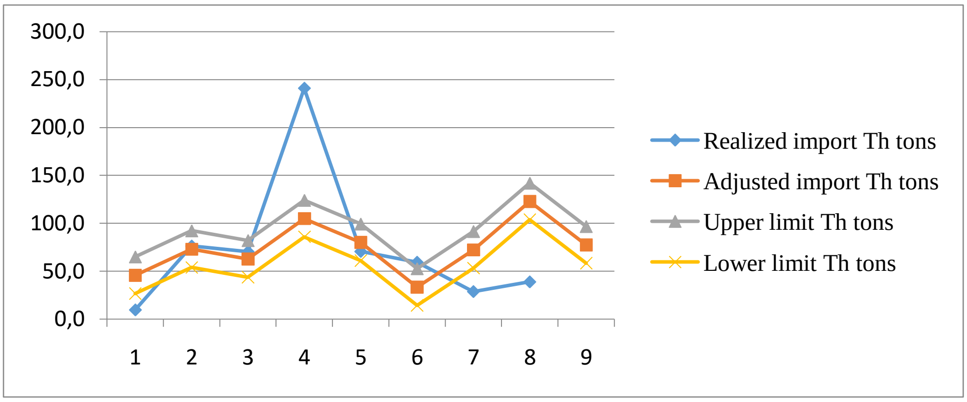

Fig no 1. The rape imports extrapolation (thousands to) based on production (thousands to) in Romania (year 2015 towards 2007-2014)

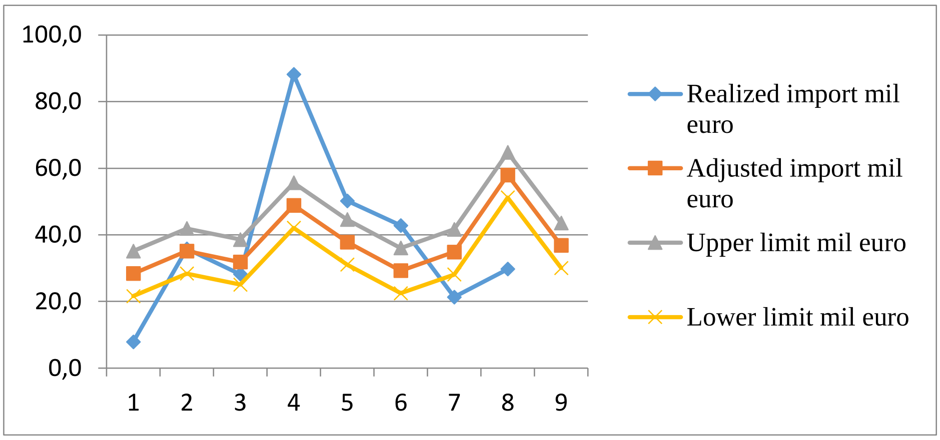

Fig no 2. The rape imports extrapolation (mil Euro) based on production (thousands to) in Romania (year 2015 towards 2007-2014)

Table 8 – The rape exports eextrapolation (thousands to/ mil euro) based on production (thousands to) in Romania (2015 period 2007-2014)

The years	Quantity (thousand tons) Y (thou to) = 0.000053• x ² + 0.03•x + 26.97			Value (million euro) Y (Mill. euro) = 0.00005•x² – 0.030•x – 32.777		
	Limit upper	Adjusted import	Limit lower	Limit upper	Import adjusted	Limit lower
2007	501.5	299.6	97.7	184.4	114.8	28.1
2008	828.9	627	425.1	302.9	233.3	163.7
2009	721.1	519.2	317.3	266	196.4	126.9
2010	1,107.2	905.3	703.4	387.8	318.2	248.7
2011	897.4	695.5	493.7	325.2	255.6	186
2012	283.2	81.3	-120.6	94.8	15.7	-27.6
2013	821.6	619.7	417.9	300.5	230.9	161.3
2014	1,238.4	1,036.5	834.6	422.6	353	283.5
2015	873	671.1	469.3	317.3	$ 247.8	178.2

- the value analysis by the extrapolation function (Y (Mil. EUR) = $0.00005 \cdot x^2 - 0.030 \cdot x - 32.777$) reflect similar correlative variations. It is worth mentioning the same year highs (2010 and 2014), the lower limit of the year 2012.

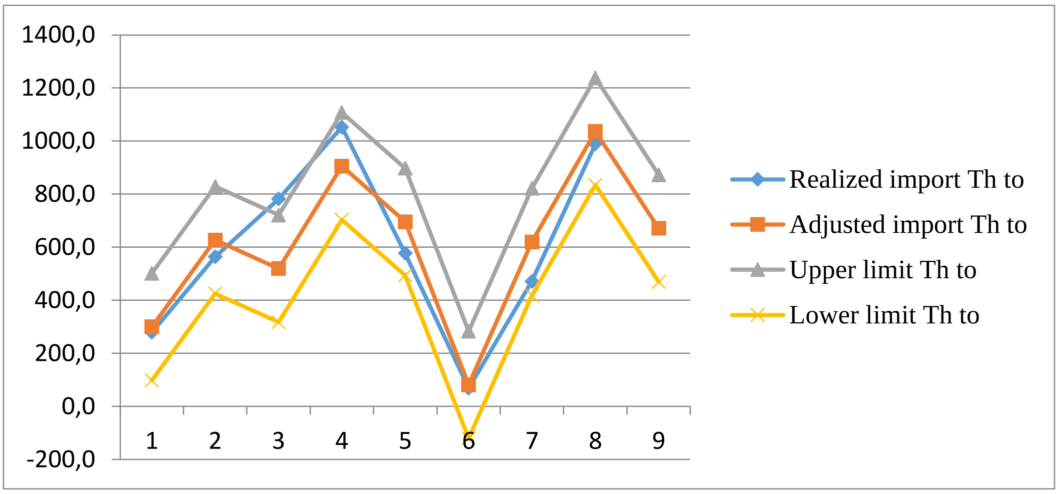

Fig no 3. The rape exports extrapolation (thousands to) based on production (thousands to) in Romania (year 2015 towards 2007-2014)

The graphics rendered complements he interpretive appearance finding an uniformity of combination of trend curves on the level of production and for the adjusted forms.

Synthetically, through the interpretation of the confidence interval resulting from the extrapolation of the regression functions it may be deducted the annual level of productions/ values that can be made in import and export activities.

CONCLUSIONS

The analysis has sought to underscore the actual aspects of rapeseed production potentialities from Romania, aiming the trends of capitalization through the trade of current market events.

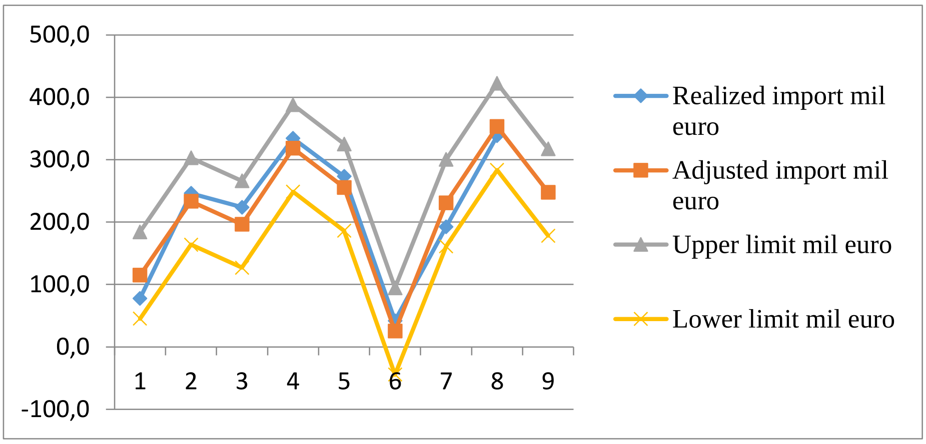

Fig no 4. The rape exports extrapolation (mil euro) based on production (thousands to) in Romania (year 2015 towards 2007-2014)

Conclusion (1). The problems investigation of the rape culture production involved a knowledge of economic efficiency from which it emerged that production potentialities are related to the interaction production expenses-prices, nationwide means an annual variability. We find the existence of a threshold limit of profitability, respectively representing the lowest level of profits (in the analysis being approx. 2000 kg/ha).

Conclusion (2) The number of farms growing rapeseed is growing, and the structure surfaces for this culture is framed towards medium and maximum limits (an area for holdings of over 2 hectares, these occupying over 95 % of the total surface area, and the majority of farms are growing to sizes 2 to 20 hectares and 50-100 ha).

Conclusion (3). The knowledge of the resources and uses structure of the rape culture products emphasizes annual variation with a trend of growth. Through comparisons carried out shows that the import levels constitute a very small contribution to resources. The structure depicted of the supply balance sheet we have corresponding variations with very resources, also the same annual variation levels. Exports, analyzed through comparisons against total imports which are prevailing (in comparison to 2007 is found a variation in the level of these exports, based on a rising trend until 2010, after which follows a decrease). At the same time, it can be highlighted also the industrial processing at which the annual level, although low, in the annual dynamic means a growth.

Conclusion (4) Through the presumptive analysis of import/export was traced the interpretative knowledge of these activities, the confidence limits of these activities, with the levels of annual variation.

References

[1]. Pirnă, I., Voicu, E., Vlăduţ V., 2011, Tehnologia de cultivare a rapiţei, INMA Bucureşti - P2, http://multilingual.bionetsyst.com/images/docs/6400677781335502327.pdf
[2]. Statistical Yearbook of Romania, INS, 2014
[3]. Supply balance sheets for the main agri-food products, year 2013, INS, 2014
[4]. Drăghici, M., Mara Fl., 2012, Indicatori statistici ce caracterizează producţia animală de carne la nivelul ţării şi a judeţului Teleorman pe perioada 2000-2008, Sesiune ICEADR, Bucureşti
[5]. The rape crop for oil, MADR, http://www.madr.ro/culturi-de-camp/plante-tehnice/rapita-pentru-ulei.html
[6]. Build Free Website of your own, Tripod, http://statisticasociala.tripod.com/tabele.htm
[7]. Cauea, Cristina, Top 5 most profitable crops, http://m.business24.ro/macroeconomie/top-5-cele-mai-profitabile-culturi-agricole-1526826,