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THE EVOLUTION OF ALFALFA, AS IMPORTANT CROP IN ORGANIC FARMING SYSTEM IN ROMANIA

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ABSTRACT

Alfalfa (*Medicago sativa*) is considered to be one of the oldest and most important fodder plants. Its current importance in improving soil fertility by fixing atmospheric nitrogen with the help of bacteria (*Rhizobium meliloti*), as well as a cover plant by sequestering carbon, its melliferous value and adaptation to different climate and soil conditions, confirm the importance of this plant in the organic farming system. As a result, in this context, the aim of this work is to highlight the cultivation of alfalfa in an organic farming system in the north-eastern area of Romania, in period 2019-2021, with particular reference to the evolution of the organic surfaces, the framework cultivation technology, as well as some variants of efficient utilization of production. Thus, the organic (certified I, II and organic) alfalfa has had an upward evolution in recent years, being cultivated on 14149,84 ha in 2017 and reaching 25612,86 ha in 2019. Also, in organic farm from North-east development region of Romania, the average production of alfalfa for dray hay was 4.8 t/ha and price of selling was 144,63 €/t, respectively, the average seeds production was 0.5 t/ha with 206,62 €/t.

Keywords: alfalfa, fodder crops, Romania, organic farming.

INTRODUCTION

Alfalfa or lucerne (*Medicago sativa* L.) is the oldest cultivated forage crop and one of the oldest crops in the world. It is a perennial forage species of the *Fabaceae* family that holds an important place in cultivated grasslands (Ahmed et al., 2019). Alfalfa is considered by specialists to be the most important perennial fodder legume producing the greatest amount of forage protein per unit area among the legumes (Schitea, 2010; Petcu et al., 2014), what it does to be cultivated all over the world for animal feed. It is most often harvested as hay, but it can also be made into silage, pellets or briquettes.

Under irrigation conditions, over 85 t of green mass or over 18 t of hay can be obtained. The fodder value is given by the high content of nutrients, crude protein in particular, with a high degree of digestibility, but also in vitamins (A, B2, C, D, E, K) and minerals (Ca, K, Na, Mg), with an important role in regulating metabolic processes directly influencing growth, health and production. Through the estrogenic substances it contains, alfalfa positively influences the reproductive cycle in animals (Fu et al., 2015). The quality of alfalfa fodder is greatly influenced by genotype and the time of harvesting (Schitea et al., 2007; Rade et al., 2022). Also, alfalfa is important as a plant improving the soil, which it enriches in nitrogen thanks to the symbiosis with *Rhizobium meliloti* bacteria, it leaves it clean of weeds, with a good structure and prevents secondary salinization, under irrigation conditions. In the steppe and forest-steppe areas, alfalfa is a basic component in the composition of mixtures for the establishment of sown meadows. Mixed with some grass

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species, alfalfa can be ensiled (Sim, 2022). It is a valuable melliferous plant, and the current varieties of alfalfa are very resistant to wintering, drought, diseases and pests. Alfalfa shows great ecological plasticity and can be cultivated in very different areas (dry steppes, forest-steppe, meadow areas, on different soils, but with a neutral-weakly alkaline reaction), being resistant to drought and low temperatures. It makes good use of irrigation water and has a high regeneration capacity after mowing (3-4 mowings when not irrigated and 4-5 mowings when irrigated).

Alfalfa provides the important raw material for the pharmaceutical industry. Alfalfa leaf protein (*Extract Fleur Lucerne*) has a high content of not only lysine but also tryptophan and threonine, making lucerne a valuable additional ingredient as a food supplement in animal diets based mainly on cereals protein. Alfalfa can be a dietary supplement of choice to tackle malnutrition and the lack of balanced diets for almost two billion people in the world (Sowiński and Adamczewska-Sowińska, 2022).

Also, according to the EU organic regulations, the organic animals must be fed with organic feed.

From an agronomic perspective, alfalfa is a great rotational crop because of its soil conditioning abilities. In addition, the perennial nature of alfalfa creates a favourable habitat for many beneficial arthropods, including pollinators and natural enemies of pests. These natural enemies help keep pest levels down in alfalfa and adjacent crops (Guerena and Preston, 2003).

MATERIAL AND METHODS

In order to respond to the principles of organic farming system, which are based on the maintenance and improvement of soil fertility through the use of leguminous crops and cover crops, such as alfalfa, the purpose of this paper is to present the role and evolution of the cultivation of this plant in achieving the objectives of organic farming in Romania. At the same time, the paper present the organic alfalfa technology of growing in an organic farm of the north-eastern development region of Romania, following the chain of obtaining the finished product and its valorisation on the profile market, including the economic calculations for both alfalfa utilized as hay and seeds.

It mentions that the farm growing the organic alfalfa crop on about 485 ha, annually.

The farm started its activity in the organic farming system in 2017, and after two years of conversion, in 2019, it passed with the entire area to organic agriculture. The agricultural machinery base has been optimized through the purchases of recent years, for the current specifics of the farm, namely the vegetal production. In addition to these machines, the farm also has a full range of equipment for ploughing, weeding, seed bed preparation, sowing and rolling.

The climate is temperate continental, with an average annual temperature of 10.5^{o}C. In the cold months the temperatures reach -4 ... -6^{o}C, and in the summer months 21-23^{o}C. The frost occurs after October 15 and ends after March 15.

The average precipitation amounts to 500-600 mm, but there are also years with 430 mm. The rainfall regime is uneven, the largest amounts falling in the summer, and the smallest in the winter. More than 35% of the annual precipitation falls in the months of May-June-July, and only 15% in the months of February-March. The torrential character is specific to precipitation. Atmospheric precipitation sums up among the lowest values in the country.

The harshness of the climate results from very hot summers, but also from cold winters, with frequent blizzards. Winds are frequent, their directions being determined by the general circulation of air masses and the orientation of the landforms.

Most of the soils belonging to the farm under study are of the chernozem type, but in some areas of the meadow there are locally glaciated and salinized soils.

In general, alfalfa remains in the lots for 4 years, entering the crops rotation with straw grains, such as winter wheat, barley and oats or with other plants, such as corn or sunflower.

The research regarding areas under conversion and certified in organic system occupied by alfalfa was carried out at the national level, using the data provided by the Ministry of Agriculture and Rural Development (MARD) for the period 2017-2019. Data available at the National Institute of Statistics and in the specialized literature were used to complete the analysis.

The pictorial representation of the degree of occupation with alfalfa, in territorial profile, at the level of the last reference year, 2019, the territorial dispersion map was made, using the software QGIS 3.16.0 "Hannover" (https://www.qgis.org/en /site/).

The original data for economic calculations from RON were converted into EUROS at the average exchange rate for the period between 2019 and 2021: EUR 1 = RON 4.8354.

RESULTS AND DISCUSSION

Results of organic alfalfa evolution in Romania

According to statistical data from 2020, the area cultivated with alfalfa increased by 5.56% in the period 2017-2019, from 391,114 ha in 2017 to 412,861 ha in 2019. Regarding the areas occupied with alfalfa in the organic farming system in 2019, the cultivation of alfalfa in the organic system occupied in Romania approximately 6.2% of the total area cultivated with this plant and 6.48% of the total area registered in organic agriculture. The areas cultivated with alfalfa had a significant increase recently. In 2017, about 14 thousand ha were registered, and in 2019, reaching over 25 thousand ha, which meant an increase of 55.24% (Table 1).

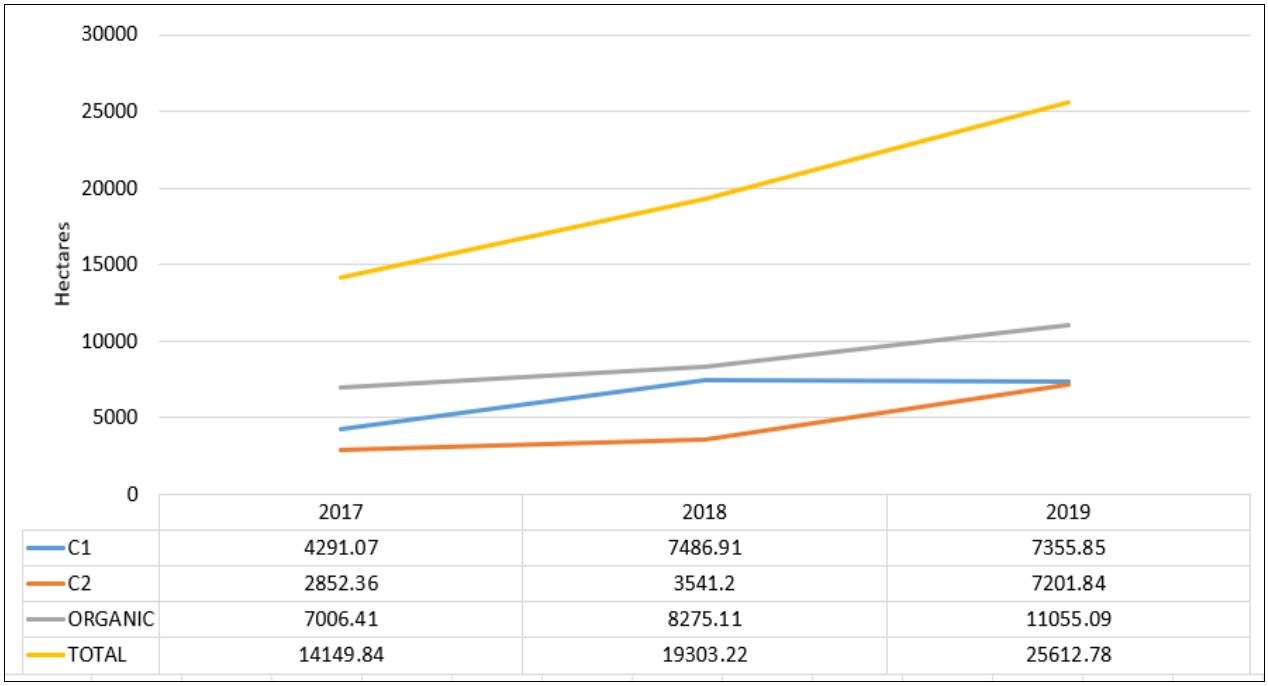
Table 1. The current status of alfalfa in organic and conversion period (year 1 and 2) of the total area with alfalfa, 2017-2019, Romania

Year	Total area (ha)	Organic area of alfalfa (certified 1, 2, organic) (ha)	The share of organic areas in the total areas cultivated with alfalfa (%)
2017	391,114	14,149	3.62
2018	408,678	19,303	4.72
2019	412,861	25,612	6.20

Source: own calculations based on data provided by MARD, 2020 and AGR108A - Area cultivated with main crops by ownership form, macro regions, development regions and counties.

Schitea et al. (2020) also emphasize an increase in the area cultivated with alfalfa in the period 2013-2018 and this was determined by:

- a slight increase in livestock numbers and the proportion of alfalfa feed in the ration to them, as a source of protein;
- the appearance of requests to export alfalfa to Arab countries, in the form of hay or pellets;
- encouraging farmers to cultivate alfalfa through "coupled subsidies", both for alfalfa forage, as well as for seed, as it also supports seed producers;
- the obligation to cultivate Romanian varieties as a condition of eligibility for projects financed by EU funds.

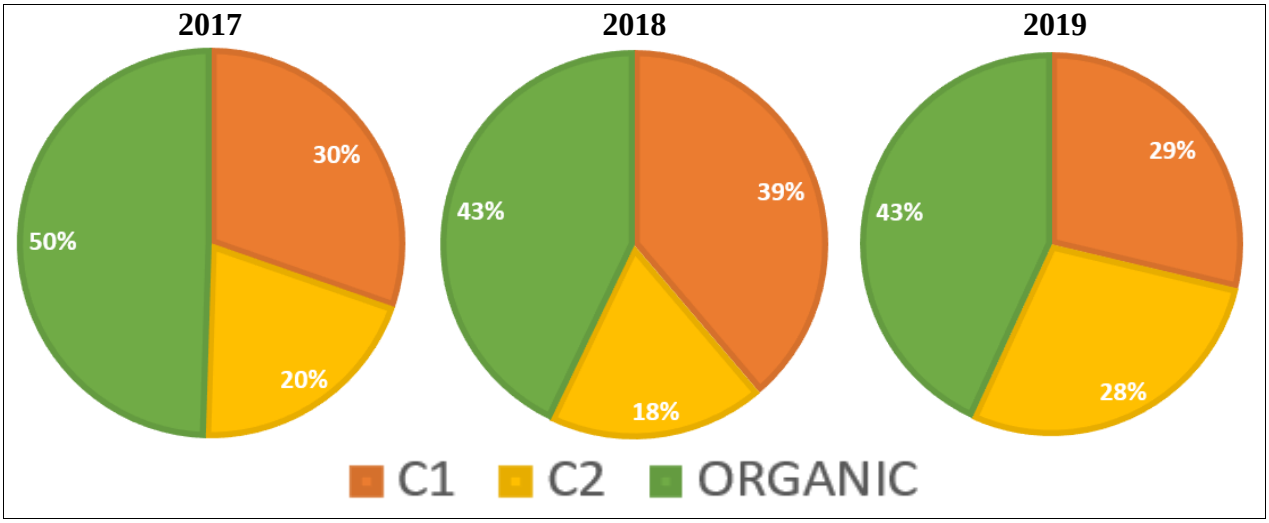


	2017	2018	2019
C1	4291.07	7486.91	7355.85
C2	2852.36	3541.2	7201.84
ORGANIC	7006.41	8275.11	11055.09
TOTAL	14149.84	19303.22	25612.78

Source: own calculations based on data provided by MARD, 2020.

Figure 1. The evolution of areas cultivated with alfalfa, depending on the certification stage (ha)

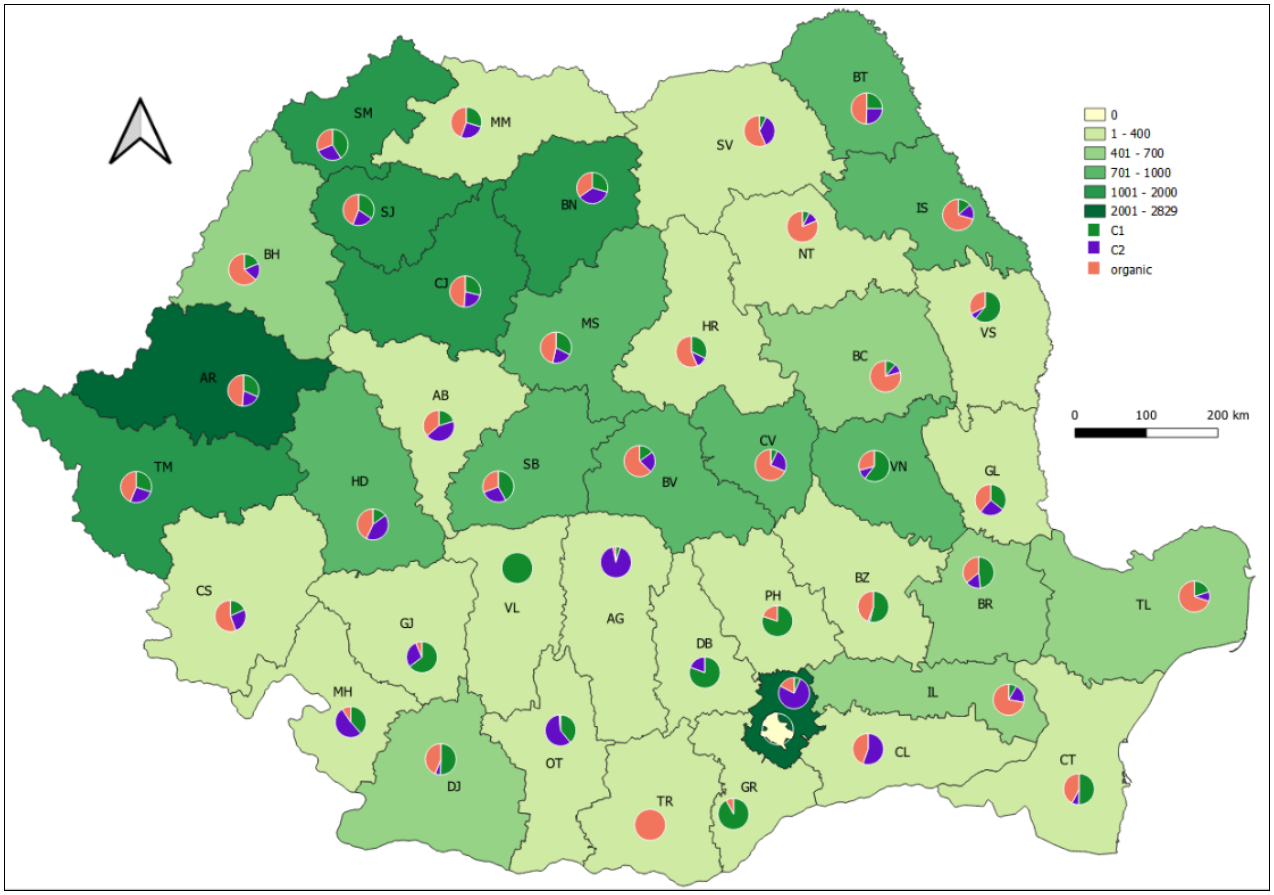
Considering the fact that alfalfa is a perennial crop with an economically viable cultivation period of 4-5 years, farmers use this crop for land conversion to organic farming. This aspect is also highlighted by the significant share of alfalfa areas established on soils in the C1 and C2 stages, from 50% in 2017 to 57% in 2018 and 2019 (Figure 2).



Source: own calculations based on data provided by MARD, 2020.

Figure 2. The share of areas cultivated with alfalfa, according to the certification stage

In territorial profile, the alfalfa crop in the organic farming system is distributed unevenly, being on the rise in most counties according Figure 3. Counties with surfaces of over 2000 ha are highlighted both in the North-West area of the country (Arad, Timiş, Sălaj, Mureş), but also in the area studied in this work, the North-East of the country, the counties of Iasi and Botoşani (Table 2).



Source: own calculations based on data provided by MARD, 2020.

Figure 3. Distribution of areas occupied with organic alfalfa, at county level, in Romania, 2019

Table 2. The current status of alfalfa in organic and conversion period (year 1 and 2) of the total area with alfalfa, 2017-2019, Romania

County	2017				2018				2019			
	C1 (ha)	C2 (ha)	Organic (ha)	TOTAL (ha)	C1 (ha)	C2 (ha)	Organic (ha)	TOTAL (ha)	C1 (ha)	C2 (ha)	Organic (ha)	TOTAL (ha)
AB	71.74	2	83.4	157.14	147.45	70.84	46.91	265.2	66.19	142.67	117.71	326.57
AG	0	0	0	0	0	0	2.45	2.45	2.9	58.3	2.45	63.65
AR	350.63	336.82	1065.36	1752.81	365.27	354.23	876.35	1595.85	713.77	441.73	1097.61	2253.11
B+IF	229.71	265.5	216.81	712.02	2358.4	107.19	691.89	3157.48	191.32	2147.67	489.99	2828.98
BC	18.47	68.35	243.1	329.92	31.7	19.4	310.23	361.33	58.13	52.07	419.79	529.99
BH	24.97	63.05	191.65	279.67	83.62	15.8	269.97	369.39	120.74	114.07	405.51	640.32
BN	196.85	66.64	146.68	410.17	380.23	150.22	208.59	739.04	298.97	368.94	353.07	1020.98
BR	41.66	22.3	143.18	207.14	0	44.98	106.43	151.41	195.46	63.36	145.55	404.37
BT	211.67	110.21	213.19	535.07	220.07	173.37	232.02	625.46	198.61	201.19	390.54	790.34
BV	69.87	136.88	251.52	458.27	112.82	52.54	276.69	442.05	114.86	166.44	480.85	762.15
BZ	46.48	1.39	37.88	85.75	13.82	10.25	28.3	52.37	116.35	4.32	95.16	215.83
CJ	115.8	430.21	278.18	824.19	328.28	149.8	617.99	1096.07	477.54	368.55	804.65	1650.74
CL	2	32.46	45.2	79.66	35.98	2	60.14	98.12	0	34.9	28.03	62.93
CS	5.24	11.43	95.92	112.59	24.87	15.66	46.6	87.13	24.76	35.59	75.86	136.21
CT	38.29	18.09	107.11	163.49	31.13	29.74	140.16	201.03	159.73	23.2	134.97	317.9
CV	341.55	133.18	67.93	542.66	153.35	443.26	198.78	795.39	52.37	180.23	502.94	735.54
DB	21.77	2	5.49	29.26	20	0	0	20	86.6	21.3	0	107.9
DJ	30.73	33.01	272.98	336.72	173.78	27.79	301.68	503.25	288	31.06	250.72	569.78
GJ	0	0	0	0	66.9	0	14	80.9	141.28	63.4	14	218.68
GL	34.89	8	172.98	215.87	106.06	22.74	141.36	270.16	135.98	98.02	146.51	380.51
GR	13.62	1	25.55	40.17	4.24	0.4	13.43	18.07	118.43	0	9.56	127.99
HD	71.4	48.42	307.47	427.29	367.94	72.58	298.96	739.48	121.33	337.13	348.37	806.83
HR	45.55	11.09	32.24	88.88	7.46	31.85	46.43	85.74	49.31	18.44	86.36	154.11
IL	195.06	121.14	199.82	516.02	330.74	268.18	178.88	777.8	52.25	120.39	445.2	617.84
IS	76.87	174.32	465.15	716.34	180.87	87.64	565.25	833.76	108.01	125.33	556.34	789.68
MH	37.64	16.77	116.56	170.97	30.65	43.7	114.6	188.95	97.76	132.78	24	254.54
MM	28.51	142.91	54.2	225.62	59.07	21.74	176.11	256.92	67.58	60.01	102.31	229.9
MS	105.89	70.92	362.31	539.12	179.9	85.72	300.92	566.54	264.09	170.31	376.91	811.31
NT	52.33	3.41	104.57	160.31	24.67	52.03	111.48	188.18	20.03	30.39	215.87	266.29
OT	0	0	16.17	16.17	27.72	8.53	0	36.25	28.92	44.16	0.63	73.71
PH	90.97	0	1.8	92.77	17.44	89.13	1.8	108.37	257.75	0	88.55	346.3
SB	54.63	39.59	343.36	437.58	399.87	17.39	298.96	716.22	414.19	265.15	301.97	981.31
SJ	137.94	54.82	320.63	513.39	228.86	126.6	258.07	613.53	390.44	248.53	500.42	1139.39
SM	242.23	148.62	122.6	513.45	350.08	232.21	190.5	772.79	541.46	367.2	408.37	1317.03
SV	16.91	5.91	58.06	80.88	19.27	23.73	26.88	69.88	5.2	24.57	38.78	68.55
TL	214.46	61.52	121.32	397.3	194.19	178.3	104.14	476.63	124.81	63.25	436.37	624.43
TM	936.55	71.94	495.21	1503.7	282.28	381.71	738.48	1402.47	549.79	475.7	801.68	1827.17
TR	33.42	51.95	57.06	142.43	0	37.42	105.11	142.53	0	0	19.14	19.14
VL	0	0	0	0	0	0	0	0	25.43	0	0	25.43
VN	62.82	70.87	154.12	287.81	49.53	62.82	158.25	270.6	454.89	77.58	221.41	753.88
VS	21.95	15.64	9.65	47.24	78.4	29.71	16.32	124.43	220.62	23.91	116.94	361.47
Total RO	4291.07	2852.36	7006.41	14149.84	7486.91	3541.2	8275.11	19303.22	7355.85	7201.84	11055.09	25612.78

Source: own calculations based on data provided by MARD, 2020.

The organic alfalfa crop technology. The placement of the alfalfa crop, on a surface of 485 ha in a studied farm, was carried out after the winter wheat, which was harvested starting on July 22, 2019.

The organic growing technology it is present in Table 3.

On the same day as ploughing, the soil was fertilized with a dose of 250 kg/ha of Calcipril, an organic certified amendment for correcting soil acidity. The decision was made to use this product, because after the soil analysis, the pH of the soil was slightly acidic.

Ploughing was carried out immediately after harvest with a 350 HP Massey Ferguson tractor with a reversible plough, at a depth of 25 cm for soil compaction and complete incorporation of plant residues and at the same time preventing the emergence of weeds. After the ploughing, a pass with the disc harrow followed to level the ploughing and close the capillarity of the soil.

When preparing the seed bed, a fertilization was carried out with Bio Ceres NPK, organic fertilizer with nitrogen, phosphorus and potassium, in a dose of 250 kg/ha, to ensure the plants an ecological environment for growth, followed by a pass with the combinatory for the destruction of weeds, the incorporation fertilizers and soil levelling. The work was carried out in the first decade of March.

The sowing work was carried out with Unia FST Drive 1500 seeders, the distance between the rows was 12.5 cm and the sowing depth was 3 cm. Alfalfa seeds, the Letizia variety, the pre-basic biological category, were used. The seed was produced by own farm by a multiplication agreement from the owner of the variety. The amount of seed sown per hectare was 23 kg/ha. The alfalfa seed was untreated, having a purity of 99% and a germination of 92%. After the sowing, a pass with a smooth roller was also carried out to stick the seeds to the soil and to have a uniform emergence.

Fertilization was carried out with organic fertiliser (Biohumusol), in a dose of 5 l/ha, being an active humic fertilizer, purely ecological, intended for foliar or root fertilization, which stimulates the growth and health of plants. Contains humic acids, humates, fulvic acids, a whole complex of irreplaceable amino acids, vitamins, natural phytohormones, macroelements (nitrogen, phosphorus, potassium, carbon, calcium, sulphur, magnesium), microelements (iron, copper, zinc, manganese, boron, molybdenum) and live bacteria of beneficial microorganisms and other substances easily absorbed by plants.

The preventive treatment against diseases and pests was carried out with Bioprotekt, a 100% organic insect-fungicide, with foliar application, containing neem oil, organic matter, microorganisms, *Trichoderma harzianum*, essential oils and humic acids with a protective role for plants. This produce has a good control in combating diseases (*Peronospora aestivalis*, *Pseudopeziza medicaginis*, *Ascochita imperfecta*, etc.) and pests (*Adelphocoris lineolatus*, *Bruchophagus roddi*, *Agrotis segetum*, *Hiplodiplozis marginala*, etc.) of plants. They were carried out two treatments with Biohumusol and Bioprotekt, two weeks before harvesting 1 and 2, to prevent the appearance of diseases and pests.

The first harvesting was done at the end of the last decade of May. The two Maschio Gaspardo mowers and the Shelbourne self-propelled mower were used. A few days later it intervened with the two Maschio Gaspardo hay rakes and immediately the next day the baling operation began, using two Krone Bigpack 1290 balers. The bales made by these balers are parallelepiped and reach a weight of approximately 600 kg of dry hay. All hay production was transported to the farm where it was sold almost entirely to livestock farmers in the surrounding areas. The average production achieved was approximately 4 t/ha of dry alfalfa hay, an aspect that also facilitated the eligibility for accessing the governmental support program linked to the alfalfa crop.

When harvesting alfalfa seed, it applied the two-phase harvesting technology, given the fact that alfalfa is cultivated in an organic system and it cannot use desiccants or other

phytosanitary products. Harvesting began in the last decade of August, when it had a percentage of at least 80% browning of the pods, harvesting the entire surface in stages with the windrower. 4-5 days after harvesting, it started harvesting with Fend 6335 Paralevel combines, equipped with a header with plant lifters. The average production obtained was 0.5 t/ha of seeds. The entire amount of seed was transferred to the alfalfa seed processing factories from where, after being processed, packaged and certified, it was capitalized in the organic market. In the middle of October, the third cut of alfalfa hay was harvested, using the same technology and the same equipment as in the case of the first harvesting. This time, the average production achieved was 0.8 t/ha of dry alfalfa hay, much lower than in first harvesting. The entire production was used for the animal breeders in the area.

Table 3. The example of organic technology for alfalfa in an organic farm in the North-Eastern development region of Romania

Data	Work	Product	Rate (kg/ha)
27.07	Fertilised	Calcipril	250 kg/ha
27.07	Tilling	Diesel fuel	30 l/ ha
17.08	Disking	Diesel fuel	17 l/ ha
05.03	Fertilised	Bio Ceres NPK	250 kg /ha
05.03	Seedbad combinatory	Diesel fuel	17 l/ha
10.03	Sowing	Letizia Prebasic seeds Cultivar Diesel fuel	23 kg/ kg 15 l/ha
15.05	Phytosanitary treatment	Biohumusol Bioprotekt Diesel fuel	5 l/ha 0.5 l/ha 6 l/ha
25.05	Harvesting 1	Diesel fuel	15 l/ha
31.05	Rake alfalfa	Diesel fuel	10 l/ha
01.06	Baled alfalfa	Diesel fuel	20 l/ha
02.06	Transporting and stacking bales	Diesel fuel	10 l/ ha
05.08	Phytosanitary treatment	Biohumusol Bioprotekt Diesel fuel	5 l/ha 0.5 l/ha 6 l/ha
25.08	Harvesting 2	Diesel fuel	6 l/ha
31.08	Alfalfa seed harvested	Diesel fuel	18 l/ ha
15.10	Harvesting 3	Diesel fuel	6 l/ha
20.10	Rake alfalfa	Diesel fuel	3 l/ha
21.10	Baled alfalfa	Diesel fuel	20 l/ha
21.10	Transporting and stacking bales	Diesel fuel	10 l/ ha

The sale of organic alfalfa from this farm has two directions: that of certified seeds and that of hay sold mainly to traders or other organic farmers.

Following our studies, regarding the economic analysis of the organic alfalfa crops within the farm, it can be highlighted that the average production of alfalfa for hay was 4.8 t/ha, and the selling price of a bale was 0.14 €/kg, thus resulting in a total value of 694.21 €/ha. In the conditions where the production cost/ha was 433.88 €/ha, the total expenses resulted in a value of 210403.51 €.

For the alfalfa seed crop, the average production of the alfalfa seed crop was 0.5 t/ha, and the selling price was 206.61 €/t, thus resulting in a total value of 1033.06 €/ha. In the conditions where the production cost per ha was 433.88 €/ha, the total expenses resulted in a value of 210403.51 €.

Table 4. Economic analysis of the organic alfalfa crop for the 2019-2021 period

Crop	Total expenses (€)	Expenses/ha (€/ha)	Total production (t)	Cost of production /t (€/t)	Price of selling/t (€/t)	Income/ha (€/ha)	Diff. Income-Expense (€/ha)	Profit (€/t)
Hay alfalfa	210403.51	433.88	2327,66	90.39	165.29	694.21	260.33	54.24
Seeds of alfalfa	210403.51	433.88	242,46	867.77	2066.12	1033.06	599.17	299.59

CONCLUSIONS

Alfalfa crops is one of the most important fodder crops in Romania, and recently the area cultivated in organic farming has increased from 14 thousand ha in 2017 to over 25 thousand ha. The organic alfalfa is concentrated in the North-West and North-East of the country, in Transylvania, where more than 2000 ha.

From the point of view of technology, it is noteworthy that the legislation in force regarding the non-use of chemical products is fully respected, and the productions obtained are somewhat lower than in the conventional system, around 4-5 t/ha dry hay.

In conclusion, for the organic farm, it is essential to use non-polluting agricultural technologies, throughout the evolution cycle of the crops, using a series of good practices that refer to the choice of an appropriate rotation, the selection of biological material, the use of new fertilizers with improving action of production level, maintenance work, disease and pest control, harvesting and utilization. In addition, the intention of the farm to diversify its activities and find new sources of additional income through the production of certified alfalfa seeds can be highlighted, which can support and improve the investment and modernization of machinery, equipment, the purchase of carbon certificates and the valorisation the most efficient use of farm resources in the context of sustainable agriculture.

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