TRADITIONAL AGRICULTURAL ALFALFA FARMING SYSTEMS IN HILLY AREAS

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Abstract. *Alfalfa, a plant with multiple uses, is gradually expanding its coverage in Romania, based on the increase of livestock but also subsidies allocated through EU CAP policies. The cultivation of alfalfa is conditioned by several factors: the pedoclimatic conditions, the feeding needs of the animals, for sale (hay, hay flour, granules, silo). In the paper we studied 14 grouped alfalfa plots, from ATU Gurahonț, analyzing the cultivation schemes and strategies for the establishment and exploitation of alfalfa crops, in traditional systems depending on the technical and financial possibilities of the farmers. The research results show that in the hilly area, where the land areas are divided, the areas cultivated with alfalfa are small, minimum 0.4 ha, maximum 3.55 ha. Alfalfa plots are grouped, making it easier to manage them, in association based on kinship and neighborhood, according to local traditions. The alfalfa productions in the analyzed area, at the level of 2020, were between: 34.6 and 62.5 t/ha^{-1} green mass, depending on the year in which it is the culture, the culture and exploitation technology but also on the exhibition of the land. Higher biomass production was recorded on the S-E slopes. Depending on the surface and the financial power, in the analyzed area, there are several scenarios of alfalfa cultivation: total mechanization of alfalfa culture, semi-mechanization of the culture (certain technological links are made manually) and entirely manual cultivation encountered on surfaces very small terrain. The elaboration of schemes and strategies for the establishment and exploitation of alfalfa crops, in traditional systems in Gurahonț, is based on the technical and financial possibilities of the landowners.*

Keywords: *alfalfa, traditional system, biomass, hill areas.*

INTRODUCTION

Alfalfa is the oldest forage plant, very well adapted to different climatic and soil conditions and is cultivated on all continents (PROSPERI ET AL. 2006; HUYGHE ET AL. 2014) and on large areas in Europe (STANISAVLJEVIĆ ET AL. 2012; TUCAK ET AL. 2014).

Alfalfa is among the most profitable agricultural crops and has a significant demand on the world market (BASIGALUP ET AL. 2014). The European Union has a major shortage of protein agricultural products, which is why the Common Agricultural Policy (CAP) aims to stimulate alfalfa production (IMBREA, 2011).

Legumes, of which alfalfa is a part, inherently have a higher content of protein (HEUZÉ ET AL. 2016) and calcium, compared to grasses in the same phenophase (COJOCARIU ET AL. 2008; PECETTI, 2014). Alfalfa provides the highest amount of digestible crude protein per hectare (VARGA ET AL. 1973) and alfalfa leaves contain fat-soluble vitamins A, D, E, K and water-soluble vitamins B, C (RADU ET AL. 2010).

The superiority of alfalfa over other fodder crops is explained primarily by the large fodder productions (PLOAIE, LIZEANU, 2013), by the superior quality of the fodder produced (STAVARACHE ET AL. 2012; FERREIRA ET AL. 2015; AVCI ET AL. 2017) and by its ability to produce for several years without being reseeded (GAITIN, SAMFIRA, 2011).

Alfalfa has a high profitability per unit area, has a very high pedoclimatic plasticity (ANNICCHIARICO, 2011), is an ameliorating plant for the soil, is a honey plant, contributes to the reduction or even elimination of chemical fertilizers and pesticides (EL-SHARKAWY, 2017), has a high resistance to drought and frost (PUTNAM, UNDERSANDER, 2006; SONG ET AL. 2019) and a

number of environmental benefits (RUSSELLE, 2014). Alfalfa also offers the possibility to diversify the mode of use (summer as green mass feed and winter as hay, silo, hay flour, briquettes, etc.) and use in sustainable agriculture (IMADI ET AL. 2016; ANGEVIN ET AL. 2017).

In Romania, between 1990 and 2017, the areas cultivated with alfalfa ranged from 442,080 ha in 1990 to 391,114 ha in 2017 (INS), a period characterized by great social and economic turmoil in Romania by the transition from the totalitarian system to the economy. market specific to the democratic system. Thus, the time interval 1990 - 2005 shows a regression regarding the areas cultivated with alfalfa, reaching in 2005, 310,532 ha. That period is also characterized by a decline in livestock.

Between 2005 - 2010, Romania's economic situation becomes more stable, especially after 2007 when Romania enters as a full member of the European Union and benefits from European funds through the Common Agricultural Policy (MAZĂRE ET AL. 2019). During this period, Romania's agriculture is gaining momentum, major changes are being made in the cultivation technologies, as a result of the acquisition of high-performance equipment, the number of animals is starting to increase and with them the areas cultivated with alfalfa. Thus, at the end of 2010, the area cultivated with alfalfa was 342,232 ha. Starting with 2015, alfalfa areas start to increase substantially with the subsidies granted to culture through the National Rural Development Program (PNDR 2014-2020). In Romania, alfalfa is a basic component in micro-crops in small farms and private households in hilly areas.

The cultivation of alfalfa is conditioned by several factors: the pedoclimatic conditions (PETCU ET AL. 2009; SCHITEA ET AL. 2014), the feeding needs of the animals, for sale, etc. (hay, hay flour, granules, silage, dehydrated alfalfa for sale).

Alfalfa cultivation technologies can be adapted, depending on: the use of feed (LUPAȘCU, 2004; AL-GAADI, SAUDI, 2018), the size of areas and the economic power of private farms/households, the possibilities of subsidizing culture.

The paper aims to highlight the cultivation schemes and strategies for the establishment and exploitation of alfalfa crops, in traditional systems in ATU Gurahonț, depending on the technical and financial possibilities of farmers. The identification, delimitation and calculation of the areas cultivated with alfalfa was done by modern techniques: marking the points with GPS and data processing with ArcGIS 10.2.1 software.

MATERIALS AND METHODS

In the paper we studied 14 plots with small areas in ATU Gurahonț, Arad County, cultivated with alfalfa, marked P1… P14 (Figure 1), taking as reference year the year 2020.

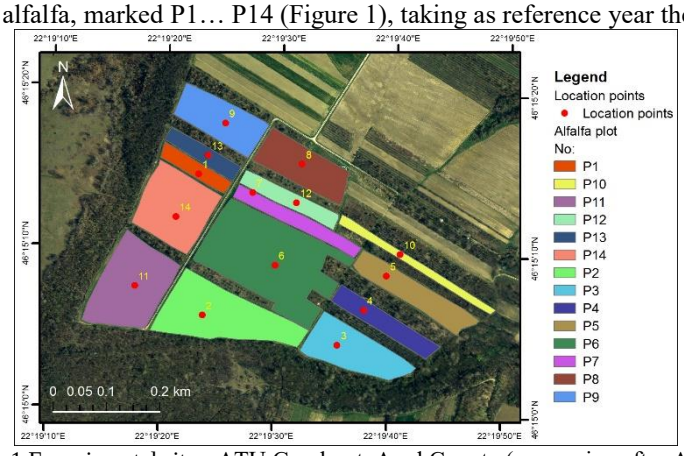

Figure 1 Experimental site - ATU Gurahonț, Arad County (processing after ANCPI)

The area of interest is located in ATU Gurahonţ, Arad county and presents altitudinal values specific to the low hills, with reduced variations from one plot to another. The slope of the land has average values between 3.2 - 10.3%, which highlights certain "deformations" on small areas. Most plots are located on slopes with sunny exposures (Table 1)

Table 1

Location and characterization of areas of interest

Location points	Stereo 70 coordinates		Altitude - average m)	Slop - average (%)	Slope orientation
	Latitude N (m)	Longitude E (m)			
P1	531699	293649	222	8,9	N, NV
P2	531428	293655	231	8,3	E, NE
P3	531370	293908	213	3,3	E, SE
P4	531437	293958	212	3,5	E, SE
P5	531503	294001	210	3,2	E, NE
P6	531524	293792	224	8,1	E, SE
P7	531663	293750	219	7,8	E, NE
P8	531718	293843	217	7,4	E, NE
P9	531797	293699	218	5,9	N, NV
P10	531544	294027	210	4,3	E, NE
P11	531485	293528	237	9,4	N, NE, NV
P12	531644	293832	221	7,7	E
P13	531735	293666	221	7,4	N, NV
P14	531617	293606	225	10,3	N, NV

A series of works highlight the role of climatic factors on the development of field plants (KARAMANOS ET AL. 2009; KARAYILANLI, VEYSEL, 2016; ŞMULEAC ET AL. 2020)

At the experimental site, temperature conditions vary from year to year. In 2020, the thermal values are generally lower compared to previous years (Table 2).

The amounts of precipitation also vary widely, and the year 2020 is marked by much larger amounts, especially in summer (Table 2).

Table 2

Weather conditions - Gurahonţ weather station (www.rp5.ru)

Anii	Multiannual monthly average temperatures - ^{0}C											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2016	-0,8	6,8	6,9	13,3	15,1	20,5	21,4	20,4	16,8	9,8	4,9	-2,2
2017	-5,0	2,5	8,7	9,9	16,2	20,7	21,7	22,4	16,1	10,8	6,2	2,7
2018	2,3	1,9	4,6	15,7	18,4	20,0	20,0	22,8	16,6	12,9	7,5	0,9
2019	-0,7	3,3	7,9	12,7	14,5	21,9	20,8	22,7	17,2	12,6	11,1	3,8
2020	-1,4	4,1	7,2	11,0	14,2	19,3	20,7	21,5	17,8	12,3	5,1	5,3
	Amounts of atmospheric precipitation – mm											
2016	90	100	72	58	67	140	91	47	50	102	95	39
2017	20	42	55	42	68	79	81	38	122	47	73	94
2018	60	51	86	35	91	217	260	67	76	94	36	153
2019	125	17	36	144	283	249	125	56	60	63	76	25
2020	32	125	64	41	126	414	282	150	82	195	32	70

For each plot of alfalfa studied (Figure 1) GPS points were marked, according to Table 1, which serve for the geographical location of areas of interest but also for monitoring in further studies (ŞMULEAC ET AL. 2016). By joining the GPS points, in the ArcGIS software, the "geometry" of each plot resulted, thus being possible to automatically determine the surfaces of the alfalfa plots. As a support for visualization, the orthophotoplan for Gurahonţ commune (ANCPI) was used. The total land area is 17.81 ha.

RESULTS AND DISCUSSION

In the paper we studied 14 alfalfa plots, from ATU Gurahonț, Arad county, in private property. Specific to the hills area of Romania, the plots of arable land are small and follow the configuration of the area (Figure 2).

1. Cadastral identification and calculation of alfalfa cultivated areas

For the location on the map of the plots cultivated with alfalfa, the GPS coordinates were introduced in the ArcGIS 10.2.1 software and thus the contour of each plot was obtained (Figure 2). In the same program, automatically calculated (*Calculate Geometry* command) the area in hectares (Table 2) but also other characteristic elements.

Figure 2 Representation and determination of alfalfa surfaces (processing after ANCPI)

The plots cultivated with alfalfa are grouped, on either side of a secondary road and are separated, in some cases, by the protective curtains (trees and shrubs) specific to the study area. The smallest plot cultivated with alfalfa has an area of 0.4 ha, out of the six under 1 ha (Table 3).

Table 3

Area of plots cultivated with alfalfa

No.	Plots	Area (ha)	No.	Plots	Area (ha)	No.	Plots	Area (ha)
1	P1	0.40	6	P6	3.55	11	P11	2.02
2	P2	2.23	7	P7	0.66	12	P12	0.59
3	P3	1.37	8	P8	1.21	13	P13	0.46
4	P4	0.76	9	P9	1.21	14	P14	1.72
5	P5	1.10	10	P10	0.51			

2. Alfalfa - in traditional crops

The grouping of the 14 plots cultivated with alfalfa, in the analyzed area, was made on the basis of the local customs of association and support in performing the main technological links (Tables 4 - 9). If in the past the first mutual aid for all the works, today, when the alfalfa crop is fully mechanized, the financial possibilities of the farmers prevail.

Thus, the owners are associated with larger areas of land, with areas between 1.72 ha (P14) and 3.65 ha (P6). In all 4 plots (P2, P6, P11 and P14), alfalfa is in the third year of

cultivation and all the technological links of cultivation have been mechanized. Green mass productions at the level of 2020 were between 56.8 and 62.5 t/ha^{-1} green mass (Table 4).

Table 4

Mechanized alfalfa production activities in association, in the third year of cultivation

Plot	Position in the field	Surface (ha)	Green mass production t/ha^{-1}	Production activities
P2		2,23	60,7	All technological links were performed mechanically Harvested hay: in the form of round, wrapped bales Hay transport: mechanized with platforms
P6		3,55	62,5	All technological links were performed mechanically Harvested hay: in the form of round, wrapped bales Hay transport: mechanized with platforms
P11		2,02	58,2	All technological links were performed mechanically Harvested hay: in the form of round, wrapped bales Hay transport: mechanized with platforms
P14		1,72	56,8	All technological links were performed mechanically Harvested hay: in the form of round, wrapped bales Hay transport: mechanized with platforms

In plot P1 and P7, located in the vicinity of the plots worked entirely mechanized, alfalfa is also in the third year of cultivation (Table 5). These plots were established in 2018, the establishment and maintenance of the crop being mechanized, in association with the owners of plots P2, P6, P11 and P14. In 2019 and 2020, the harvest was done manually and the hay was transported with the animals from the households. Green mass productions at the level of 2020, were between 55.3 and 57.8 t/ha^{-1} green mass (Table 5).

Table 5

Semi-mechanized alfalfa production activities in association, in the third year of cultivation

Plot	Position in the field	Surface (ha)	Green mass production t/ha^{-1}	Production activities
P1		0,40	55,3	All technological links for the establishment and maintenance of alpha culture were carried out mechanized Mowing hay - manual operation Gathered from the furrow and made haystacks - manual operation Transport in households - with animals
P7		0,66	57,8	All technological links for the establishment and maintenance of alpha culture were carried out mechanized Mowing hay - manual operation Gathered from the furrow and made haystacks - manual operation Transport in households - with animals

From table 6, it can be seen that in plot P10, in an area of 0.51 ha all operations were performed manually, due to isolation and poor financial possibilities of the owners.

Table 6

Manual alfalfa production activities in the third year of cultivation

Plot	Position in the field	Surface (ha)	Green mass production t/ha^{-1}	Production activities
P10		0,51	40,3	All technological links for setting up and maintaining the alpha culture were done manually Mowing hay - manual operation Gathered from the furrow and made haystacks - manual operation Transport in households - with animals

Another alfalfa cultivation strategy, depending on the financial possibilities, is shown in table 7. The three owners joined forces and incurred the costs of setting up and maintaining the alfalfa crop in the first year, the operations being carried out mechanized. The mowing operation was performed mechanized, and the other assembly operations were performed manually; the hay was transported with the horse cart of the owner of plot P4. Alfalfa green mass productions in the fourth year of cultivation, at the level of 2020, were between 44.8 and 47.3 t/ha^{-1} green mass (Table 7).

Table 7

Semi-mechanized alfalfa production activities in association, in the fourth year of cultivation

Plot	Position in the field	Surface (ha)	Green mass production t/ha^{-1}	Production activities
P3		1,37	47,3	All technological links for the establishment and maintenance of alpha culture were carried out mechanized Mowing hay - mechanized Gathered from the furrow and made haystacks - manual operation Transport in households - with animals
P4		0,76	46, 6	All technological links for the establishment and maintenance of alpha culture were carried out mechanized Mowing hay - mechanized Gathered from the furrow and made haystacks - manual operation Transport in households - with animals
P5		1,1	44,8	All technological links for the establishment and maintenance of alpha culture were carried out mechanized Mowing hay - mechanized Gathered from the furrow and made haystacks - manual operation Transport in households - with animals

The owners of the alfalfa plots P8 and P9, also work in association. All the technological links of culture were carried out mechanized, except the transport of the bales which is carried out with the horse cart. Alfalfa cultivation is in the second year of cultivation, at the level of 2020 the productions being between 45.5 and 49.3 t/ha^{-1} green mass (Table 8).

The plots cultivated with alfalfa in table 9 were established in 2020. The owners associated themselves and more easily borne the costs of establishing alfalfa cultivation. Being small areas of land, the mowing and gathering of hay was done manually. The hay was

transported by horse-drawn cart. In the first year, at the level of 2020, two stitches were registered at work.

Table 8

Semi-mechanized alfalfa production activities in association, in the second year of cultivation

Plot	Position in the field	Surface (ha)	Green mass production t/ha^{-1}	Production activities
P8		1,21	49,3	All technological links for the establishment and maintenance of alpha culture were carried out mechanized Harvested hay in the form of rectangular bales Hay transport in households - with animals
P9		1,21	45,5	All technological links were made mechanically Harvested hay in the form of rectangular bales Hay transport in households - with animals

Table 9

Semi-mechanized alfalfa production activities in association, in the first year of cultivation

Plot	Position in the field	Surface (ha)	Green mass production t/ha^{-1}	Production activities
P12		0,59	35,5	All technological links for the establishment and maintenance of alpha culture were carried out mechanized Mowing hay - manual operation Gathered from the furrow and made haystacks - manual operation Transport in households - with animals
P13		0,47	34,6	All technological links for the establishment and maintenance of alpha culture were carried out mechanized Mowing hay - manual operation Gathered from the furrow and made haystacks - manual operation Transport in households - with animals

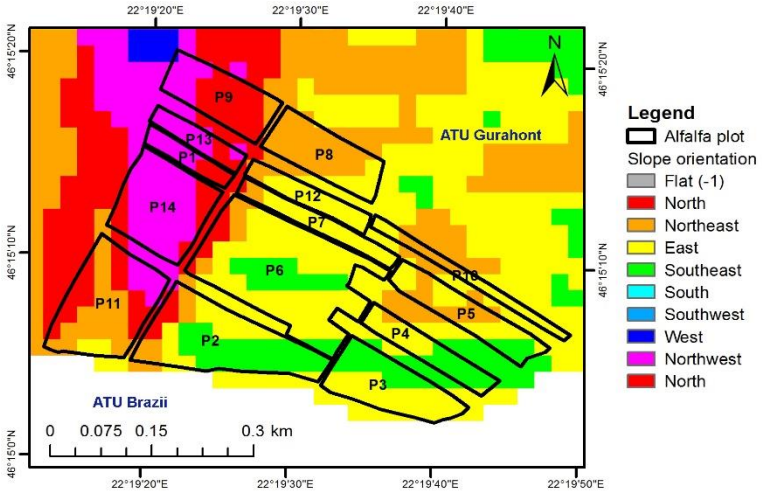

Figure 3 Slope orientation in the experimental site

Alfalfa productions respect the cultivation technology, the climatic conditions of the year, the soil (COJOCARIU, 2005) but also the land exposure. Thus, in the analyzed area, the relief is disturbed, dominating the S-E exposure (Figure 3). The S-E exhibition favors the growth and development of alfalfa plants and implicitly the production of biomass.

CONCLUSIONS

The research results show that in the hilly area, where the land areas are divided, the areas cultivated with alfalfa are small: minimum 0.4 ha, maximum 3.55 ha. The alfalfa plots are grouped, making it easier to manage them, in association based on kinship and neighborhood, according to local traditions.

Depending on the surface and the financial power, in the analyzed area, several alfalfa cultivation scenarios are distinguished:

Scenario 1. Total mechanization of alfalfa culture. This includes alfalfa plots, with larger areas, located in the vicinity, which also record the highest productions.

Scenario 2. Semi-mechanization of alfalfa culture, with two variants:

1. All technological links for the establishment and maintenance of alfalfa cultivation were carried out mechanized, mowed hay - mechanized, gathered from the furrow and made into furrows - manual operation, transport to households - with animals;
2. All the technological links for the establishment and maintenance of the alfalfa crop were carried out mechanized, mowing the hay, gathered from the furrow and making heads - manual operations, transport in households - with the animals.

Scenario 3. All technological links for the establishment and maintenance of alfalfa cultivation, as well as the harvesting and transport of hay were carried out manually, due to the isolation and the precarious financial possibilities of the owners.

The alfalfa productions in the analyzed area, at the level of 2020, were between: 34,6 and 62,5 t/ha^{-1} green mass, depending on the year in which it is the culture, the culture and exploitation technology but also on the exhibition land.

The elaboration of schemes and strategies for the establishment and exploitation of alfalfa crops, in traditional systems in ATU Gurahonţ, is based mainly on the technical and financial possibilities of the landowners.

BIBLIOGRAPHY

AGENŢIA NAŢIONALĂ DE CADASTRU ŞI PUBLICITATE IMOBILIARĂ (ANCPI) – baza de date geospaţiale - https://geoportal.ancpi.ro/portal/home/

AL-GAADI, SAUDI K.A., 2018 - Impact of raking and baling patterns on alfalfa hay dry matter and quality losses, Journal of Biological Sciences 25 (2018) 1040–1048

ANGEVIN, F., FORTINO, G., BOCKSTALLER, C., PELZER, E., MESSÉAN, A., 2017 - Assessing the sustainability of crop production systems: Toward a common framework? Crop Protection, Volume 97, July 2017, Pages 18-27

ANNICCHIARICO, P., PECETTI, L., ABDELGUERFI, A., BOUIZGAREN, A., CARRONI, A.M., HAYEK, T., MHAMMADI BOUZINA, M., MEZNI, M., 2011 - Adaptation of landrace and variety germplasm and selection strategies forAlfalfa in the Mediterranean basin. Field Crops Research 120:283-291

ARCGIS DOCUMENTATION - https://desktop.arcgis.com/en/documentation/

AVCI, MUSTAFA, RÜŞTÜ, HATIPOGLU, SELAHATTIN, ÇINAR, NUMAN, KILIÇALP, 2017 - Assessment of yield and quality characteristics of alfalfa (*Medicago sativa* L.) cultivars with different fall dormancy rating, Legume Research, DOI: 10.18805/LR-364

BASIGALUP, D., IRWIN, J., FUGUI M.I., ABDELGUERFI-LAOUAR, M., 2014 - Perspectives of alfalfa in Australia, China, Africa and Latin America, Legume Perspectives, Issue 4, 9-10.

BAZE DE DATE CLIMATICE – www.rp5.ru

COJOCARIU, L., 2005 - Producerea furajelor, Ed. Solness, ISBN 973-729-038-0, pp.315

COJOCARIU, L., MOISUC, A., RADU, F., MARIAN, F., HORABLAGA, M., BOSTAN, C., 2008 - Qualitative changes in the fodder obtained from forage legumes and *Lolium multiflorum* in the ecological conditions of Eastern europe, Options Méditerranéennes, 167-171

EL-SHARKAWY, MAHMOUD, SAMIR, TALAAT, RIZK, EL-BESHSBESHY, ESAWY, KASEM, MAHMOUD, NASSER IBRAHIM, ABDELKADER, RANIA, MOHAMED, AL-SHAL, ALI, M. MISSAOUI, 2017 - Response of Alfalfa under Salt Stress to the Application of Potassium Sulfate Nanoparticles, American Journal of Plant Sciences 08(08):1751-1773

EUROPEAN ENVIRONMENT AGENCY (EEA), 2017 - Digital Elevation Model (DEM) with spatial resolution at 25 m, Produced using Copernicus data and information funded by the European Union - EU-DEM layers; owned by the Enterprise and Industry DG and the European Commission:https://www.eea.europa.eu/data-and-maps/data/copernicus-land-monitoring-service-eu-dem

FERREIRA, JORGE, F. S., MONICA, V. CORNACCHIONE, XUAN, LIU, DONALD, L. SUAREZ, 2015- Nutrient Composition, Forage Parameters, and Antioxidant Capacity of Alfalfa (*Medicago sativa*, L.) in Response to Saline Irrigation Water, Agriculture 5(3), 577 -597

GAITIN, D., SAMFIRA, I., 2011 - A bibliographic study on genetic progress in the species *Medicago sativa*, Research Journal of Agricultural Science, 43 (4)

HUYGHE, C., DELABY, L., ROSELLINI, D., VERONESI, F., 2014 - Perspectives of alfalfa in Europe, The journal of the International Legume Society Issue 4, 5-6

HEUZÉ, V., TRAN, G., BOVAL, M., NOBLET, J., RENAUDEAU, D., LESSIRE, M., LEBAS, F., 2016 - Alfalfa (*Medicago sativa*). Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. https://www.feedipedia.org/node/275 Last updated on November 22, 2016

IMADI, S.R., SHAZADI, K., GUL, A., HAKEEM, K.R., 2016 - Sustainable Crop Production System. In: Hakeem K., Akhtar M., Abdullah S. (eds) Plant, Soil and Microbes. Springer, Cham DOI https://doi.org/10.1007/978-3-319-27455-3_6

IMBREA, F., 2011 - Proiectele de cercetare în domeniul agriculturii în parteneriat public-privat–provocări privind managementul și finanțarea, Agrobuletin AGIR, An III

INSTITUTUL NAȚIONAL DE STATISTICĂ (INS) – online: http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

KARAMANOS, A., PAPASTYLIANOU, P., STAVROU, J., AVGOULAS, C., 2009 - Effects of Water Shortage and Air Temperature on Seed Yield and Seed Performance of Alfalfa (*Medicago sativa* L.) in a Mediterranean Environment. J. Agron. & Crop Sci., 195: 408-419

KARAYILANLI, E., AYHAN, V., 2016 - Investigation of feed value of alfalfa (*Medicago sativa* L.) harvested at different maturity stages. Legume Research, 39 (2): 237-247

LUPAȘCU, M., 2004 - Lucerna – importanța ecologică și furajeră, Î.E.P. Știința Chișinău, Republica Moldova

MAZĂRE, R,, NEAGA, B., TIMARIU, R., BOSTAN, C., COJOCARIU, L., 2019 - Behavior of alfalfa (*Medicago sativa* L.) for hay under conditions in Romania, Research Journal of Agricultural Science, Vol. 51, Isue 4, pp. 273 - 281

PECETTI L., 2014 - Alfalfa as a grazed crop, Legume Perspectives, Issue 4, 27-28.

PETCU, E., SCHITEA, M., CIRSTEA, V.E., 2009 - The effect of water stress on cuticular transpiration and its association with alfalfa yield. Romanian Agricultural Research, 26: 53-56

PLOAIE, N., LIZEANU, A., 2013 - Cultura lucernei și a trifoiului, Editura Mast

PROGRAMUL NAȚIONAL DE DEZVOLTARE RURALĂ (2014 – 2020) - https://www.madr.ro/docs/dezvoltare-rurala/2021/PNDR.2020_V12_26.01.2021.pdf

PROSPERI, J.M., JENCZEWSKI, E., ANGEVAIN, M., RONFORT, J., 2006 - Morphologic and agronomic diversity of wild genetic resources of *Medicago sativa* L. collected in Spain. Genet Resour Crop Evol 53:843-856

PUTNAM, D., UNDERSANDER, D., 2006 - The future of alfalfa forage quality testing in hay markets, Published IN Proceedings, Western Alfalfa Symposium, Reno, NV 11-13, December, 2006. (http://alfalfa.ucdavis.edu)

RADU, F., AHMADI, M., COJOCARIU, L., MARIAN, F., BOSTAN, C., BOROZAN, A., 2010 - Genotype-biostimulations interactions in some high quality active principles appearance for alfalfa, Research Journal of Agricultural Science 42 (1), 526-530

RUSSELLE, M.P., 2014 - Environmental benefits of growing perennial legumes in cropping systems, Perspectives, Issue 4, 11-12

VARGA, P., MOGA, I., KELLNER, E., BĂLAN, C., IONESCU, M., 1973 - Lucerna. Editura Ceres, Bucureşti.

SCHITEA, M., CONSTANTINESCU, E., BORA, C., DRĂGAN, L., PETCU, E., OPREA, G., PETRESCU, E., 2014 - Teodora and Cezara – new romanian alfalfa cultivars developed at N.A.R.D.I. Fundulea, AN. I.N.C.D.A. Fundulea, Vol. LXXXII, 155-169

SONG, Y., LV, J., MA, Z. ET AL., 2019 - The mechanism of alfalfa (*Medicago sativa* L.) response to abiotic stress, Plant Growth Regul 89: 239. Doi: https://doi.org/10.1007/s10725-019-00530-1

STANISAVLJEVIĆ, R., BEKOVIĆ, D., DJUKIĆ, D., STEVOVIĆ, V., TERZIĆ, D., MILENKOVIĆ, J., DJOKIĆ, D., 2012 - Influence of plant density on yield components, yield and quality of seed and forage yields of alfalfa varieties, Romanian Agricultural Research, No. 29, 245-254

STAVARACHE, M., VÎNTU, V., SAMUIL, C., MUNTIANU, I., POPOVICI, C.I., CIOBANU, C., 2012 - Forage productivity of alfalfa (*Medicago sativa* L.) in the pedo-climatic conditions from Moldavian sylvosteppe, Bulletin UASVM Agriculture 69(1), 271-279

ŞMULEAC, A., POPESCU, A.C., IMBREA, F., POPESCU, G., ŞMULEAC, L., 2016 - Topographic and cadastre works for the establishment of an animal farm with NPRD funds, measure 121, Vărădia, Caraş-Severin county, Romania, International Multidisciplinary Scientific GeoConference: SGEM, 3, 685-692

ŞMULEAC, L., RUJESCU, C., ŞMULEAC, A., IMBREA, F., RADULOV, I., MANEA, D., ... & PAŞCALĂU, R. 2020 - Impact of Climate Change in the Banat Plain, Western Romania, on the Accessibility of Water for Crop Production in Agriculture. Agriculture, 10(10), 437

TUCAK, M., POPOVIĆ, S., ČUPIĆ, T., KRIZMANIĆ, G., ŠPANIĆ, V., ŠIMIĆ, B., MEGLIČ, V., 2014 - Agro-morphological and forage quality traits of selected alfalfa populations and their application in breedin, Turkish Journal of Field Crops, 19(1), 79-83