Environmental Engineering and Management Journal

March 2015, Vol.14, No. 3, 657-663
http://omicron.ch.tuiasi.ro/EEMJ/

"Gheorghe Asachi" Technical University of Iasi, Romania

RESEARCH ON THE PRODUCTION OF FORAGE FOR THE AGRO -TOURISTIC FARMS IN ROMANIA BY CULTIVATING PERENNIAL LEGUMINOUS PLANTS

Aurel Călina*, Jenica Călina

University of Craiova, Faculty of Agriculture, 19 Libertătii Str., 200421 Craiova, Romania

Abstract

The paper is the result of research conducted for approximately 20 years in the agro tourism field and also rural tourism, as well as in natural and cultivated pastures, at the Faculty of Agriculture and Horticulture, University of Craiova. Based on these studies it was concluded that the research in this field has been less realistic so far, because it was strictly oriented towards obtaining high forage production, but of questionable quality due to high content of residual chemicals. Currently, in tourism activities and other specific areas of food production, the demand for natural products (bio or eco) has greatly increased to ensure a quality taste and high security and traceability. To assist the forage manufacturers and workers in tourism activity we considered appropriate and necessary to study this particularly valuable forage, to which by applying minimal chemical treatments, high yields with a very low degree of chemical residues will be obtained, with a high nutritional quality and traceability, while a cuisine with higher value taste and food safety can be obtained.

Key words: agri-tourism, food safety, protein feed, traceability

Received: April, 2013; Revised final: June, 2014; Accepted: June, 2014

1. Introduction

The agro tourism activity in Romania must develop constantly, as from the research and studies conducted it was concluded that this is a complex activity, with considerable advantages on the economic and socio-cultural landscape, which was almost entirely forgotten during the communist period (Călina, 2007; Călina et al., 2011a).

The impact of this activity is visible, quick and significant, manifesting itself in the Romanian rural area by: acquisition of new professional skills, stopping the exodus of people from rural to urban areas (Moinet, 2006; Călina, 2008), increasing the number of jobs and substantially reducing rural unemployment (Gartner, 2004; Grolleau, 1987), increasing the income of farms and households engaged in such work (Călina et al., 2009, 2010a), increasing the number and volume of investments in the area, direct source of capitalization and modernization of agricultural holdings, improving housing (Stoian, 2006), increasing the level of education, culture and civilization of villagers, harnessing typical products from agriculture and traditional cuisine of the region (Călina et al., 2010a, 2011b), assuring sustainable development of rural communities through wise use of all resources, the decrease of the removal process of agricultural and forest lands from the agricultural and forestry circuit (Hernández-Mogollón et al., 2013; Jeangros, 2006; Louwagie et al., 2009).

Due to these advantages and favorable quality/price ratio of the agro tourism activity recorded by Plog (2003), the research team sought to support small farms and agro tourism farms in our country by conducting research regarding the production of protein forage with high nutritional

* Author to whom all correspondence should be addressed: e-mail: aurelcalina@yahoo.com

value and a lower percentage of chemicals, to be used in animal feed, grown on the farm.

Obtaining such feed with high nutritional and ecological value is particularly important because the activity of farms and agro pensions should be attached to the function of recreation and leisure and also that of protection and conservation of natural ecosystems and anthropic resources (Barke, 2004).

2. Materials and methods

To assess the agro touristic phenomenon, specific methods frequently encountered in specialized literature were used, which permitted the accomplishment of a clear, pertinent and realist analysis and diagnosis of the phenomena, from a quantitative as well as a qualitative point of view.

The experiences regarding the protein forage production were conducted at the Experimental Center for the Meadows Culture, Preajba, of the Faculty of Agriculture, University of Craiova, Romania, on an albic luvisoil, characterized by physico - chemical properties which produce low fertility, to truly make use of this soil aeration processes are needed as well as applying organic and mineral fertilizers in high doses and amendments to correct the acid reaction (Peţ et al., 2005, 2006).

Since the research was conducted in an area with strongly acidic soils where some perennial legumes such as alfalfa or sainfoin cannot be sustained for long periods of usage, and because the trefoil gives lower production quantities with high expendability, red clover (Trifolium pratense) was chosen in both pure culture and mixed with perennial forage grasses, under the form of temporary meadows. Ionescu (1998, 2001) confirms that the red clover cultivated on acid soils provides high yields of superior quality feed.

2.1. Objectives of research

The research undertaken during 2009 - 2010 had two main objectives:

1. the production of feed with high protein and ecological value;
2. determining the chemical composition of forage and its influence on the quality and traceability of food products (Dragomir, 2001);

In order to achieve these complex objectives, the investigations have taken into account the following major aspects:

- the behavior of the Trifolium pratense species in pure culture, used for forage;
- the influence of amendment under the form of calcium carbonate ($CaCO_3$) on dry matter production of the red clover (Trifolium pratense) in pure culture;
- the effect on the quantity and quality of dry matter production of the red clover (Trifolium pratense) produced by applying organic fertilizer (manure) in pure culture (Iepema et al., 2006; Muntean, 2002);
- the influence of lime amendments and organic fertilizer on annual growth in production; the influence of lime amendments and organic fertilizer on the quality of red clover forage.

2.2. Working method

During the experiments, the Merviot soil was sown with red clover in 2009, on April 5th, being considering the method of subdivided parcels with 3 factors (Vântu, 2004). It was generated a schema of 2 x 3 x 2 type in 4 repetitions as follows:

A: Factor - soil amendment with 2 graduations:

a1 – unchanged

a2 –amended with 5.5 t/ha of calcium carbonate ($CaCO_3$)

B: Factor - organic fertilizer with 3 graduations:

b1 – unfertilized

b2 - 20 t / ha manure

b3 - 40 t / ha manure

The surface of a large lot was of 15 m x 5.6 m = 84 m^2, of a small lot of 5.6 m x 2.5 m = 14 m^2, from which harvest, 10 m^2.

Harvesting was performed at the beginning of flowering transition, at a height of 4 to 5 cm with a mower. Concurrently with every mowing, samples were gathered in order to determine the dry substance and chemical composition.

3. Results and discussion

The studies and researches performed have lead to the conclusion that providing animal food in sufficiently high quantity and quality, along with other products, determines an increase in the living standards of the population. Achieving this goal involves increasing the number of animals and their production, which is possible only by ensuring an adequate forage base in terms of quantity and quality (Abberton, 2007; Muntean, 2002). In Romania, the predominant source of forage is represented by the permanent grassland with a high share and also temporary meadows that even though currently occupy small areas, provide significant productions. Among fodder plants, the perennial legumes are of particularly importance, whether used in pure culture or mixed with perennial grasses, the productions made by these are always of a high level (Vantu, 2004).

The perennial leguminous crops coupled with other measures (amendments, fertilizers etc.) could play an important role in increasing soil fertility through the ameliorative qualities they possess and furthermore contribute to obtaining, within farms and agro tourism households, a constant and ecological animal productions of a high quantity and quality (Croitoru and Miluţ, 2008; Dragomir, 2001).

Within this context, the research conducted at the Experimental Center for Meadows Culture Preajba - Gorj have looked at determining factors of the culture technology that can be considered as

viable solutions for spreading these valuable forage plants, grown single or in mixture with perennial grasses, as temporary grasslands in farms and agro tourism households, across the Subcarpathian area of Oltenia and the entire country.

Considering that the produced forage is designed primarily for agro touristic farms and households, the research was focused primarily on two directions, obtaining forage high in protein, of a high a quality and environmentally friendly and the development of food products with a high nutritional value and low in residual chemicals accumulated from the treatment applied to plants (Charles, 1988).

The achievement of such natural products that ensure a high degree of traceability and food safety to tourists visiting farms and agro pensions in Romania and other regions should represent a primary concern for all researchers in our country and all over the world (Stoll, 2007). The research team arrived to this conclusion considering that so far all investigations conducted nationally and internationally have mainly focused on obtaining high productions of low ecological quality, with large side effects on human health.

This research aimed to demonstrate that culinary dishes prepared from animal products produced by feeding with forage of nutritional and environmental quality are highly recommended, as they provide a high quality taste and the highest level of security and traceability. Furthermore the research based on the experiences carried out on poorer acid soils, specific to sub mountain and hill areas, must prove that these areas can obtain high productions with a high nutritional and ecological quality, through a technology that involves applying reduced chemical treatments to forages (Ionescu, 2003).

In order to meet the objectives, the influence of amendments and organic fertilizers on the production and on the quality of forage produced on pastures grown with red clover (Trifolium pratense) in pure culture, in the form of temporary grassland was taken into account.

3.1. Effects of amendments on red clover (Trifolium pratense) crop production

The first phase was aimed at analyzing the effect of amendments on crop production of red clover. The results have shown that 7.32 t/ha dry matter (s.u.) resulted without amendment, and 8.45 t/ha s.u. (1.13 t/ha more, meaning about 16%), when 5.5 t/ha calcium carbonate were applied to correct the soil acidity (Fig. 1). Statistical analysis of the data showed that the difference between amended and not amended crop production was around 1 t/ha s.u., which was found as insignificant.

The values obtained cannot confirm with adequate certainty that the application of lime amendments to clover is inefficient, whereas calcium carbonate has positive effects not only on mass production plant and plant chemical composition, but also on the characteristics of the soil, by correcting its acidity (Dunea, 2008).

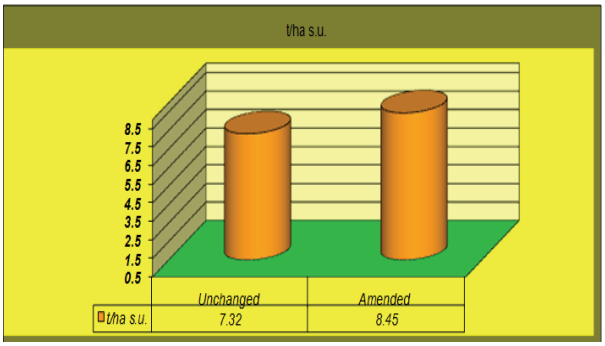

Fig. 1. Culture production of red clover (Trifolium pratense) under the influence of calcareous amendments (t / ha s.u., average 2009 - 2010)

3.2. Effect of organic fertilizer on red clover (Trifolium pratense) crop production

Very significant results were obtained by applying organic fertilizers on the culture of *Trifolium pratense* (Table 1). The sizes of these improvements depend on the fertilizer dose. Considering the alternative with 40 t/ha manure added during two years, an average production of 9.28 t/ha s.u. resulted, with more than 3.37 t (almost 37%) than in the alternative without manure. The dose of manure of 20 t/ha resulted in a production of 8.75 t s.u. (more than the witness with 2.84 t, almost 20%), high enough to be considered for use in practice (Table 1). The high value of the production obtained after fertilization with manure and substantial gains in comparison with the unfertilized soil recommend organic fertilizers to be used with priority for the clover crops.

The results confirm that, by applying organic fertilizers even on acid soils with lower natural fertility, large productions with high nutritional and ecological value can be obtained.

3.3. Effect of amendments combined with organic fertilizer on red clover (Trifolium pratense) crop production

At this stage, the way in which the manure application had undergone both on amended background and also on unchanged background was observed (Table 2). It can be noticed that the manure used in doses of 20 and 40 t/ha improved crop production comparative with the variants without manure as described above, the data being comparable to those obtained by other researchers (Hatch et al., 2014; Ionescu, 2001). In all working variants, the increases in crop production given by lower doses of organic fertilizer were significantly distinct, and those given by the double dose were very significant.

The experiments conducted at the Center for the Meadows Culture, under the hill region of

Oltenia, display that the area offers good conditions for this culture, which spread over larger areas, can help in improving soil characteristics and provide animals with large quantities of forage of excellent quality.

3.4. Dynamics of red clover (Trifolium pratense) crop production

Careful monitoring of red clover production showed that the crop can be exploited in economic conditions for only two years, meaning 2009 and 2010, while in the following years the plants disappeared massively. This resulted in changing the culture and plowing the land in order to cultivate it with other plant species (this phenomenon was also noted by Mosimann, 2008).

In the first year, the clover production was enhanced with 29-36%, but we were not able to find some correlations between the experienced factors and the production share in the total amount collected in the two years of operation (Fig. 2). In the second year (2010) much higher yields were harvested that reported to the amount of dry matter produced in the two years, represented 64-72% of the total production. Thus it can be asserted, with some approximation, that the clover expresses about 1/3 of the production potential in the first year and the remaining 2/3 in the second year of vegetation.

3.5. Chemical composition of red clover crop

Analyzing the red clover forage in terms of chemical composition it was found the applied amendments and organic fertilizers had a strong influence. The data in Table 3 underline that, under the influence of different treatments, the gross protein content of the forage was at a higher level, ranging between 17.99% and 22.58%. The cellulose content ranged from 21.19% to 26.33%.

Slightly lower values were recorded in the levels of phosphorus, potassium and calcium. Phosphorus was determined at a rate of 0.31-0.45%, being therefore present in optimal amounts in the plants. The potassium content of plants was found of 1.22 - 1.92%, as deficient in all variants, while calcium in the plants ranged from 0.33 - 0.55%.

Similar results were obtained in other areas with acidic soils. It was also found that the presence of large quantities of mobile aluminum favored strong leaching of the potassium and decreased the plants absorption capacity for this element (Ionescu, 1998, 2001).

The correct exemplification of the effect of the separate impact of amendments and organic fertilizers on the chemical composition of the red clover forage is shown in Table 4. The percentage of gross protein as it is displayed has increased, reaching the value of 20.58% on amended soil, in comparison with the content of the forage on unchanged soil of 19.66%, which can demonstrate the qualitative role of calcium used as amendment, but the results have not statistical significance.

Comparing the two doses of organic fertilizer used, it was identified that the highest amount of protein was obtained at a dose of 20 t/ha (20.85%). The dose of 40 t/ha manure resulted in a protein content of 19.48%, lower even for the variant without manure (20.03%), which demonstrates that there is no direct correlation between the amount of proteins in the forage and the quantity of organic fertilizer applied.

The dynamics of the chemical composition of forage can be explained as follows: a larger amount of manure is found due to increased nitrogen input into the soil, which help plants to develop stronger tissues. This resulted in a high content of cellulose (24.87%) in the working variant when the soil was ammended with 40 t/ha manure, compared to 20 t organic fertilizer variants or without manure (cellulose, 22.55% respectively 22.94%).

Table 1. The influence of organic fertilizers on the production of cultivated Trifolium pratense (average from 2009 to 2010, t / ha s.u.)

No.	*Version*	*Absolute production (t/ha s.u.)*	*%*	*Difference*	*Significance*
1	Unfertilized	5.91	100	-	Witness
2	20 t/ha manure	8.75	148	2.84	***
3	40 t/ha manure	9.28	157	3.37	***

DL 5 % = 1.05 t/ha s.u.; DL 1 % = 1.43 t/ha s.u.; DL 0.1 % = 2.12 t/ha s.u.

Table 2. The combined influence of organic fertilizers with the amendment on the production of cultivated Trifolium pratense (average from 2009 to 2010, t / ha s.u.)

No.	*Amendment*	*Organic fertilizers*	*Absolute production (t/ha s.u.)*	*%*	*Difference*	*Significance*
1	Unchanged	0	5.91	100	-	Witness
2		20 t/ha manure	8.75	148	2.84	**
3		40 t/ha manure	9.28	157	3.37	***
4	Amended 5,5 t/ha $CaCO_3$	0	6.75	100	-	Witness
5		20 t/ha manure	8.96	133	2.21	**
6		40 t/ha manure	9.77	145	3.02	***

DL 5 % = 1.39 t/ha s.u.; DL 1 % = 1.99 t/ha s.u.; DL 0.1 % = 3.01 t/ha s.u.

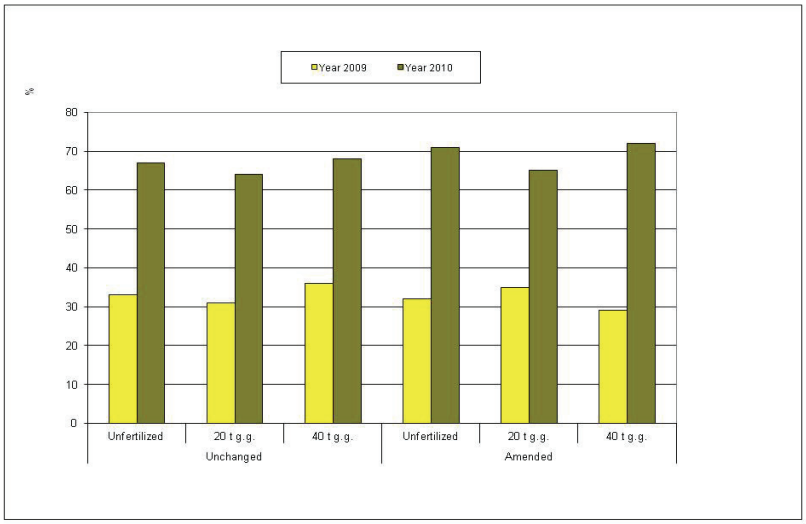

Fig. 2. The yearly dynamic of the red clover crop production (*Trifolium pratense*), (%)

Table 3. The chemical composition of the Trifolium pretense cultivated forage (%)

No.	*Amendment*	*Organic fertilizers*	*Gross proteins%*	*Gross cellulose %*	*P%*	*K%*	*Ca%*
1	Unchanged	0	21.,95	21.95	0.37	1.63	0.33
2			18.88	23.57	0.41	1.92	0.39
3		20 t/ha manure	22.33	21.19	0.31	1.28	0.46
4			18.96	25.15	0.35	1.47	0.41
5		40 t/ha manure	21.32	26.03	0.41	1.39	0.55
6			17.99	26.33	0.43	1.42	0.47
7	Amended, 5.5 t/ha $CaCO_3$	0	21.55	22.46	0.37	1.53	0.36
8			20.60	24.44	0.38	1.87	0.39
9		20 t/ha manure	22.58	21.52	0.35	1.29	0.53
10			20.14	23.10	0.33	1.58	0.41
11		40 t/ha manure	21.51	23.37	0.42	1.22	0.54
12			19.36	24.85	0.45	1.51	0.47

Table 4. The separate influence of amendments, organic fertilizers on nutritional parameters of Trifolium pratense cultivated forage (%)

Nutritional parameter / *Version*	*Gross proteins (%)*	*Gross cellulose (%)*	*P (%)*	*K (%)*	*Ca (%)*
Unchanged	19.66	23.99	0.38	1.51	0.46
Amended 6 t/ha $CaCO_3$	20.58	23.32	0.37	1.49	0.50
0	20.03	22.94	0.39	1.75	0.40
20 t/ha manure	20.85	22.55	0.36	1.44	0.42
40 t/ha manure	19.48	24.87	0.43	1.39	0.48

Analyzing the evolution of cellulose content in red clover crop, it can be noted that this is inversely proportional with the protein percentage: the lowest cellulose content was determined when the protein registered the highest values (amended, 20 t/ha manure) and vice versa. The phosphorus was within the optimal range, not being influenced by amendments, and the effect of organic fertilizers is not significant, because they have low phosphorus content.

The potassium content was in all cases below the limit of 2%. The amount of this macro-element decreased from 1.51% (unchanged) to 1.49% (amended) and 1.75% (without manure) to 1.39% (manure 40 t / ha). The decrease is explained by the antagonism that exists between calcium and potassium: in the presence of calcium (from amendment or manure) the potassium is blocked in insoluble forms. The percentage of calcium in plants was positively influenced by the amendments, increasing from 0.46% (unchanged) to 0.50%. Its percentage increased under the influence of organic fertilizers from 0.40% (without manure) to 0.48%.

4. Conclusions

The red clover grown on amendment conditions of over 5.5 t/ha $CaCO_3$ has averaged

insignificant increases, while manure, applied when preparing the ground work had a very large influence on the production of dry matter. The best results were obtained with the dose of 40 t/ha, but higher production costs and lower profitability were obtained. The dose of 20 t/ha led to a higher production, similar to that of the maximum dose of organic fertilizer, with important economic efficiency.

The analysis of the chemical composition of red clover forage showed that the application of chemical products, such as lime amendments and a dose of 20 t/ha manure led to a substantial increase in the proportion of protein and lower percentage of cellulose; the phosphorus is present in optimum values, the potassium is below 2%, while calcium is stimulated to some extent by the dose of amendment and organic fertilizer.

By analyzing and interpreting the percentage values of the main chemicals contained in the red clover forage it was demonstrated that addressing this research topic is necessary for agro tourism farms and households, as high yields were obtained with a lower residual chemicals content in the case of amended cultures.

It was determined that the red clover (Trifolium pratense) is a profitable crop, recommended for high capitalization of acidic soils. The organic fertilizers in dose of 20 t/ha are profitable due to relevant increases in production, since the amendments applied do not raise the cost of production, bringing substantial benefits and high food security for the animal food specialties, obtained from this forage.

Therefore, relevant and documented interpretation and analysis of our research demonstrated that protein forage with a high nutritional and ecologic value was obtained, revealed by chemical analyses. They can be designated for agro tourism farms and households, through which food products of animal origins can be manufactured, which would offer a high degree of food security and traceability to the local traditional culinary specialties offered to tourists since the soil can support the rotation of cultures due to its improvements. The results confirm that this crop is a viable solution for obtaining large productions with a high nutritional and ecological value, due to its capacity to diminish the effects of land degradation in a changing climate and its integration into sustainable food production systems.

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