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STUDY ON THE AGROFORESTRY SYSTEM WITH OAK TREES (*Quercus robur* L.) IN THE CONTEXT OF CHANGING CLIMATE

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Abstract. *The permanent meadows from the plains and hills of Transylvania, grazed with cattle from ancient times, are covered with scattered trees providing shade to animals. The current global warming underline the need for the protection of animals and the vegetal layer of the meadows from the sunlight and drought. In this paper, we studied the positive effects of the presence of trees on the productivity and biodiversity of meadows in comparison with the treeless surfaces exposed to a more accentuated aridity. Under oak trees (Quercus robur L.) we found 57 plant species compared to 45 in open land, with over 13 t/ha green mass production compared to approx. 10 t/ha in open land and a pastoral value of approximately 69 compared to 56 of a treeless grassland. In addition to increasing biodiversity and productivity, under the oak trees the agrochemical values of the soil increase, having also additional production of acorns, animal shade and pastoral landscapes.*

Keywords: grassland with oak trees, biodiversity, grass production, pastoral value

1. Introduction

According to WMO (World Meteorological Organization) data, in the century (1901-2000) the average temperature of the globe increased by 0.6 Celsius degrees. For Romania this increase is only 0.3^0C.

One of the most effective measures to fight against climate changes is to expand the agroforestry system already in use in the countries with drier climates.

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This system is known as 'dehesa' and 'montando' in Spain and Portugal as well as “agroforestry” in the USA [8, 9].

Due to the ecological conditions from our country in some areas there are in use several combinations of agriculture and woody vegetation such as: pasture - trees (grove, glade, hurst), hayfields - fruit trees (orchards), arable crops - fruit trees and other mixed forms [3, 4, 5].

The accentuation of global warming in the last decade, which also affects our country, has raised the issue of studying the existing agroforestry systems in order to promote them in the future. There are already numerous studies in this direction at European and global level [1, 2].

In Romania, these researches are at the beginning, in this paper being presented a case study for the combination of grassland - oak trees from South Eastern Transylvania.

2. Materials and methods

The studies on the agroforestry system pasture – oak trees were carried out in the village of Mercheașa belonging to the commune of Homorod, located in the plateau with the same name from South Eastern Transylvania (Figure 1).

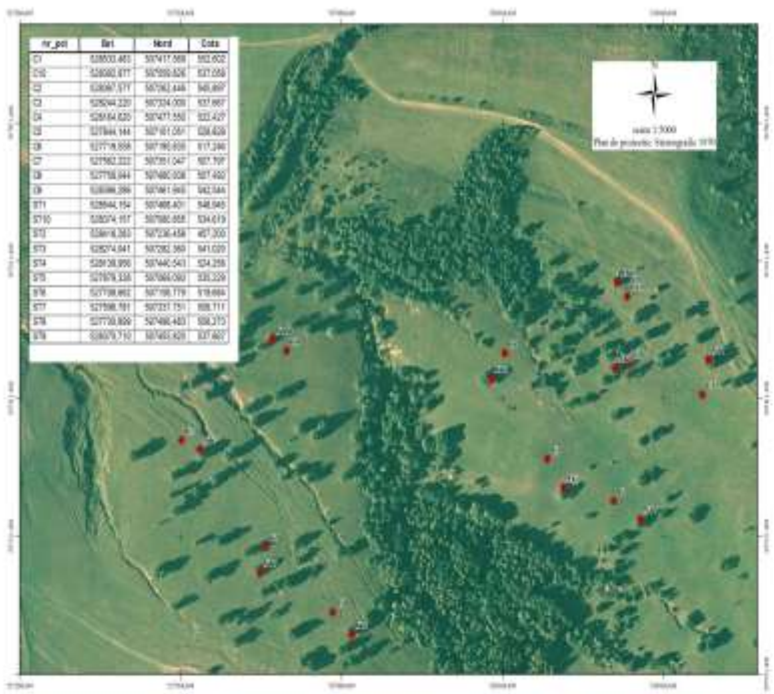

Fig. 1. Agroforestry system pasture – oak trees, Mercheașa Village, Homorod Plateau, South Eastern Transilvania, Romania

2. Materials and methods

The studies on the agroforestry system pasture – oak trees were carried out in the village of Mercheașa belonging to the commune of Homorod, located in the plateau with the same name from South Eastern Transylvania (Figure 1).

Here, on an area of 40 hectares we found 85 trees of the species *Quercus robur* L, most of them being century-old. Among them a specimen with a height of 21 m and a stem diameter of almost 3 m was evaluated as being over 900 years old, considered the oldest in our country.

Specifically, floristic surveys were carried out under the canopy of oaks and in parallel in open ground. Soil samples were taken at a depth of 0-10 cm and also plant samples were collected for agrochemical and feed quality determinations, according to usual methods.

Based on the floristic surveys, the productivity of the vegetal layer (pastoral value and fodder production) was evaluated according to a new method [7].

2. Results and discussions

The following table shows the results of soil agrochemical analyses that have a direct influence on grass productivity (Table 1).

Table 1. Agrochemical values of soil samples collected from open ground and from under the oaks (*Querqus robur*)

Specification	unit	1.Open ground	2. Under the oaks	Diff. 2-1 +, -	%
pH in H_2O	ind.	5.2	5.35	+0.05	103
Humus	%	7.01	7.19	+0.18	103
Nitrogen index	%	4.64	4.99	+0.25	108
Mobile phosphorus	ppm	2.7	10.0	+7.3	370
Mobile potassium	ppm	168	> 400	> 232	> 238
Amount of exchangeable bases	me/100g	16.7	19.4	+2.7	116
Hydrolytic acidity	me/100g	8.5	8.5	0	100
Cation exchange capacity CEC	me/100g	25.2	27.9	+2.7	111
Base saturation BS	%	66.3	69.5	+3.2	105
Exchangeable aluminum	me/100g	0.099	0.075	-0.024	76

From these data it results that all agrochemical parameters are more favorable under oaks compared to the open field soil, without shade.

Thus, the reaction of the soil (pH) the degree of saturation in bases (BS%) and humus (%) are higher by 3-5% and the exchangeable aluminium lower by 24%. Fertilizers (P, K) are 2-4 times higher under trees than in open ground, mainly due to the manure of animals that are resting in their shade.

The improvement of soil properties changed for the better the composition and productivity of the grass carp (Table 2).

Table 2. Floristic composition of open ground (L) and from under oak trees (U) from grassland of Mercheașa – Homorod, 530 m of altitude

Species	Presence (class)		Participation %			%	Index	
	L	U	L	U	Diff.+ -		F	M
Vegetation layer	x	x	97.0	97.7	+0.7	101	x	x
Poaceae								
Festuca rupicola	V	V	29.4	28.0	-1.4	95	5	5
Agrostis capillaris	V	IV	10.5	6.3	-4.2	60	7	5
Lolium perene	IV	V	2.3	23.4	+21.1	1,017	9	8
Cynosurus cristatus	IV	II	1.6	1.6	+0.0	100	7	4
Nardus stricta	III	II	2.8	0.4	-2.4	14	3	0
Danthonia decumbens	II	I	0.8	0.2	-0.6	25	3	0
Briza media	II	-	0.3	-	x	x	5	2
Anthoxanthum odoratum	I	I	0.5	0.5	+0.0	100	5	3
Festuca pratensis	I	I	0.2	0.2	+0.0	100	8	9
Deschampsia caespitosa	I	I	0.2	0.2	+0.0	100	3	0
Festuca arundinaceae	I	-	0.1	-	x	x	8	9
Phleum pratense	-	II	-	0.3	x	x	9	8
Holcus lanatus	-	I	-	0.1	x	x	6	6
Dactylis glomerata	-	I	-	0.3	x	x	9	8
Poa annua	-	I	-	0.2	x	x	7	2
Bromus secalinus	-	I	-	0.1	x	x	3	0
Fabaceae								
Trifolium repens	V	V	11.6	7.6	-4.0	66	8	5
Trifolium pratense	V	V	3.2	3.3	+0.1	103	8	7
Lotus corniculatus	V	III	4.3	0.8	-3.5	19	8	6
Genista tinctoria	III	II	2.4	0.5	-1.9	21	3	0
Dorycnium pentaphyllum	I	-	0.5	-	x	x	3	0
Medicago falcata	-	I	-	0.2	x	x	7	6
Other plant families								
Plantago lanceolata	V	V	2.6	2.3	-0.3	88	6	1
Achillea millefolium	V	IV	2.1	1.3	-0.8	62	6	4
Leontodon autumnalis	IV	V	1.1	1.8	+0.7	164	5	3
Prunella vulgaris	IV	III	3.8	1.6	-2.2	42	4	2
Pyrus piraster	IV	III	1.5	0.5	-1.0	33	3	0
Agrimonia eupatoria	IV	II	1.0	0.4	-0.6	40	3	0

Taraxacum officinale	III	V	1.1	5.3	+4.2	482	7	3
Crataegus monogyna	III	III	0.9	0.5	-0.4	56	3	0
Centaurium erythrea	III	I	0.5	0.1	-0.4	20	3	0
Fragaria viridis	II	IV	1.0	1.0	+0.0	100	4	1
Daucus carota	II	III	0.5	0.7	+0.2	140	6	5
Filipendula hexapetala	II	I	1.0	0.3	-0.7	30	5	4
Galium verum	II	I	0.8	0.2	-0.6	25	5	4
Ranunculus acer	II	I	0.5	0.2	-0.3	40	1	0
Salvia pratensis	II	I	0.9	0.1	-0.8	11	4	4
Thymus montanum	II	I	0.9	0.1	-0.8	11	4	2
Plantago major	I	IV	0.2	1.5	+1.3	750	5	3
Cichorium intybus	I	II	0.1	0.3	+0.2	300	5	6
Rosa canina	I	II	0.1	0.3	+0.2	300	3	0
Lysimachia nummuaria	I	I	0.3	0.1	-0.2	33	3	0
Potentilla reptans	I	I	0.4	0.1	-0.3	25	3	0
Ranunculus sardous	I	I	0.1	0.2	+0.1	200	1	0
Carex palescens	IV	-	2.2	-	x	x	4	3
Centaurea phrygia	III	-	1.2	-	x	x	4	6
Juncus tenuis	II	-	0.6	-	x	x	3	0
Carduus achantoides	I	-	0.2	-	x	x	2	0
Cirsium vulgare	I	-	0.2	-	x	x	2	0
Euphrasia rostkoviana	I	-	0.2	-	x	x	3	0
Juncus conglomeratus	I	-	0.3	-	x	x	3	0
Polygonum aviculare	-	V	-	1.7	x	x	5	3
Geranium pratense	-	II	-	0.3	x	x	4	4
Glechoma hederaceae	-	II	-	0.4	x	x	3	0
Alchemilla vulgaris	-	I	-	0.2	x	x	6	4
Capsella bursa pastoris	-	I	-	0.1	x	x	4	3
Galium cruciata	-	I	-	0.3	x	x	3	0
Hypericum perforatum	-	I	-	0.2	x	x	3	0
Lamium maculatum	-	I	-	0.1	x	x	3	0
Mentha longifolia	-	I	-	0.1	x	x	4	6
Myosotis arvensis	-	I	-	0.1	x	x	3	0
Quercus robur (puieți)	-	I	-	0.2	x	x	3	0
Rhinanthus glaber	-	I	-	0.3	x	x	3	0
Sisymbrium officinale	-	I	-	0.2	x	x	3	0
Urtica dioica	-	I	-	0.1	x	x	3	0
Veronica chamaedrys	-	I	-	0.1	x	x	4	2
Viola arvensis	-	I	-	0.2	x	x	3	0

Total species (nr.)	**45**	**57**	**+12**	**126**	**x**	**x**
From which: - fodder	**26**	**33**	**+7**	**127**	**x**	**x**
- not fodder	**19**	**24**	**+5**	**126**	**x**	**x**
Participation of fodder species	**83.5**	**91.8**	**+8.3**	**110**	**x**	**x**
Participation of harmful species	**13.5**	**5.9**	**-7.6**	**44**	**x**	**x**
Bare soil	**3.0**	**2.3**	**-0.7**	**78**	**x**	**x**
Pastoral value (PV)	**56.3**	**68.8**	**+12.5**	**122**	**x**	**x**
Phytomass index	**3.92**	**4.95**	**+1.03**	**126**	**x**	**x**
Fodder production (GM t/ha)	**9.79**	**13.36**	**+3.57**	**136**	**x**	**x**

It is observed that the species *Lolium perenne*, very good fodder species, with an average participation of 2.3% in open ground is over 10 times better represented under oaks.

In general, the number of forage species increases under trees by 28% and overall participation in phytomass by 10% influencing the productivity of the vegetal layer which is more valuable under trees.

Specifically, the estimated pastoral value (PV) increases from 56.6 to 70.7 respectively by 25% and feed production (GM t/ha) from 9.6 to 14.2 t/ha, an increase of 48%, which confirms the economic value of the vegetal layer under the oaks.

The better quality of the feed under oaks was also confirmed by chemical analysis (Table 3).

Table 3. The differences between the chemical quality parameters of the grass, from open ground (L) and under trees (U) from Mercheașa

Chemical parameters for feed quality	**Participation %**			**%**
	L	**U**	**Diff. + -**	
CP	17.1	19.7	+2.6	115
ASH	10.5	11.3	+0.8	107
FB	28.5	27.3	-1.2	96
ADF	32.6	31.4	-1.3	96
ADL	3.7	2.7	-1.1	71
NDF	53.5	52.8	-0.7	99
DMD	63.4	69.4	+6.0	110
OMD	58.6	65.9	+7.3	113

Thus, the crude protein content (CP) and the digestibility of the dry matter (DMD) or of the organic matter (OMD) are 10-15% higher for the grass under the trees than for the grass from the grassland's open field.

The data show that the optimal digestibility of feed (important indicator of conversion into animal products) of over 65% is found only under trees (65.9 - 69.4%).

To all these advantages of the agroforestry system with oaks we can add the production and feed quality of the acorn, the shade for the welfare of the animals and the protection of the vegetal layer during the hot periods. So, the next stage of research will have to establish the quantity and quality of acorns produced by these oaks, as well as the welfare of animals that benefit from shade, parameters that are more difficult to quantify.

Conclusions

(1) The agrochemical properties of the soil under oaks (*Quercus robur*) are much more favorable for plant growth than open ground conditions.

(2) Grass production and fodder quality is better under oaks than in grasslands located in open field by 25-50%.

(3) In the conditions of global climate warming the agroforestry system with oaks, due to its economic, protective and aesthetic qualities, needs to be preserved and expanded.

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