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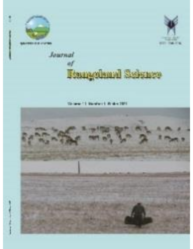

Review and Full Length Article:

Importance of Black Locust (*Robinia pseudoacacia*) Foliage in the Extension of the Grazing Season and in the Reduction of Damages Caused by Climate Change (a Review)

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Received on: 01/06/2020
Accepted on: 30/08/2020

Abstract. Forest grazing of cattle, horse and sheep is allowed under certain strict regulations. Black locust forests have major importance amongst domestic forestry (Central Europe), as their habitat are situated on less productive sand soils. In most cases there is no other option than setting trees next to the grazing areas. Black Locust (*Robinia pseudoacacia*) leaves and the herbage of *Gramineae* amongst the trees provide excellent supplemental feed at the beginning and in the last period of the grazing season. It can be well integrated into a rotational grazing system, thus grazing season can be prolongedwith two months. Digestibility of black locust is significantly lower than alfalfa because of its high lignin content. The protein level however is remarkably high (20%) during spring. Despite its lower feeding value, it is still a considerable forage due to its role as rumen filling feed, and also because other valuable plants also available during forest grazing. Black locust trees contain poisonous compounds in the crust. Such compounds are robiine and fazine. Diverse rangelands with clump act a major role in healthy grassland ecosystems. Foliage provides basic forage and shade at once. Groundwater usage of trees also discussed as they might be competitors of the basic grassland association.

Key words: Foliage forage, Forest grazing, Digestibility, Traditional lifestyle, Semi intensive feeding

Introduction

Interconnection of extensive livestock keeping and arboreal vegetation is contemporaneous with farming, all over Europe. Upkeep of woody pastures and pastoral forests, forest grazing, collection of wild fruits, oak-mast, usage of leaf-fodder, and any other labour process, in which pastoral farming and arboreal vegetation are interconnected in any extent, is an integral part of the agrosilvo-pastoral system (Gyuricza & Borovics, 2018).

When the Hungarian conquering ancestors arrived in the Carpathian Basin, they have found arboreal steppes instead of sparsely wooded areas. However, the ever increasing population, livestock numbers and wood demand resulted in the extermination of a vast amount of forests, also transforming many of them into woody pastures. In theory, pastoral forests and woody meadows could have been suitable for dual exploitation as well as for preventing soil deterioration, however the two directions of exploitation (mostly due to human factors) worked for the detriment of each other, as grazing cattle gladly consume fresh, sappy sprouts and saplings. A majority of these are mainly present in young cropland regenerating forests, restricted from grazing, which resulted in uncounted number of misuses. Furthermore, a significant number of new sprouts is located in the foliage of trees, a great number of which was therefore often and by choice cut by the pastors in order to satiate the cattle as soon as possible. The first limitation of the widespread practice of forest grazing was included in the Forestry Act of 1879. This change became a major nuisance for landowners too, as a significant part of pasture area – due to better tax conditions – was registered as a cultivated forest area. This initiated an intensive logging of woody pastures and pastoral forests by the landowners in order to prevent the exclusion of livestock from their own lands and pastures (Salata, 2009).

Several areas of forest grazing activities are only known from historical data, since during the 20th Century, extensive grazing farming has significantly lost ground. By the beginning of the 21st Century the operation of arboreal-woody grazing systems has decreased by a great extent, however, in the past few years the transformation of agricultural support system, innovation opportunities and the realisation of the advantages of extensive livestock keeping has brought back this type of agrosilvo-pastoral system into focus (Gyuricza & Borovics, 2018).

According to the Hungarian operative Forestry Act (Act XXXVII), the forest is classified as: “An area registered as forest in the National Forest Crop Database, a stock of trees consisted of forest tree species specified by legal measures, whose area has at least 20 m average width concerning the base distance of peripheral trees, whose natural latitude reaches 5000 m^2, with an average height exceeding 2 m, covering its soil in at least 50% measure (30% in case of soil protection). Beyond this, the Act segregates the following groups:

- Single tree;
- Alley: typically, an area with linear extension, covered with trees, in which the average base distance of the single trees as well as the peripheral trees located at the shorter extension sides is not greater than 20 m.
- Tree group: the epigraphy of trees located in an area smaller than 5000 m^2, typically with the non-linear extension and covered with trees to at least 50 % extent.
- Woody pasture: a piece of land cultivated as a pasture, in which the covering provided by the projections of tree crownsin consistent partition is no more than 30 %.
- Tree plantation: a forest typically consisting of foreign tree species or their artificial hybrids planted in a regular system, intensively tended with an at least 15 years long cutting cycle.”

Rediscovery of forgotten methods that were widespread regular practices in the past centuries is getting more and more significance during the implementation of conservation and land-protection endeavors. The farmers have to adapt to the unstoppable process of climate change. As of today, there are already several problems caused by more and more extreme weather conditions, increasingly hot summers and the decrease of productive abilities. The presence of trees can prevent the deterioration of pasture soil (Salata, 2009). Thus, such traditional land-utilising methods as the use of pasture forests and woody meadows are more and more often get into the centre of attention (Halasz *et al.*, 2015).

The occurrence of such exaggerated meteorological phenomena as rainstorms or enduring droughts shows an increasing tendency (Heap, 2014). Aridity zones – based on (Palfai, 2002) shown in Fig. 1. indicate that climate change has impacts even in fertile, good structured soils. Average hay yield is 1.5 T ha^{-1}, which is barely enough to keep 1 cattle ha^{-1} on extensive rangeland (Halasz *et al.*, 2018). The research area could provide double amount of hay in rainy summers but the metronome effect of late spring precipitation is more frequent (Janko *et al.*, 2010). The competitiveness of Hungarian agriculture – and within its livestock breeding and keeping – greatly depend on what kind of technological answers are we able to give to the questions of the changing environment. According to certain professional opinions, even during the next five years, the inconsistent precipitation dispersion is going to be something that we have to adapt to. Otherwise, we persistently fall behind on the markets where quality is preferred. Hungarian export market primarily expects quality products (and a great extent of bio-products) from our country, which can only be provided through proper water management and quality foraging (Penksza *et al.*, 2013). The metronome-type “climate-swings” – similarly to el Nino effect (Janko *et al.*, 2010) – can be attenuated by old-new solutions (Bajnok *et al.*, 2011). One of such solutions is foliage-foddering, where with we can provide forage to our livestock without opening winter-depots, while our pastures also have enough time to regenerate.

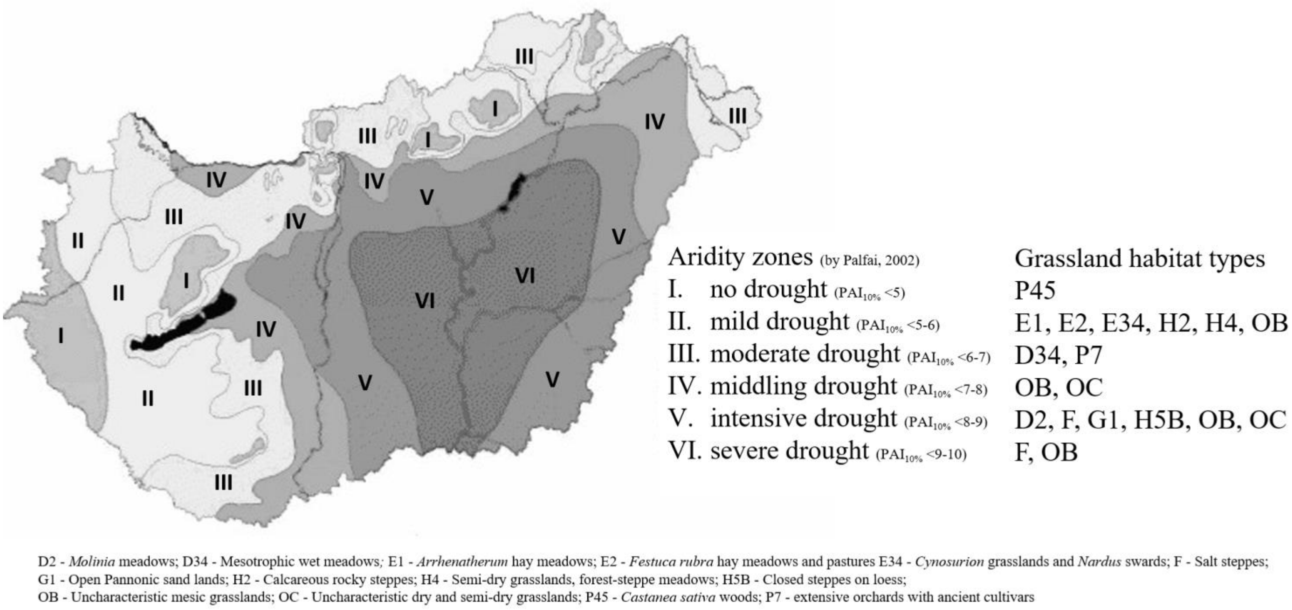

Fig.1. Aridity zones and grassland types in 2018in Hungary (Halasz *et al.*, 2018)

Under foliage-foddering we mean the leaves of all kinds of arboreal plants (Ainalis & Tsiouvaras, 1998), that have any feed values (Szemethy *et al.*, 2012). High tannin acid content and other anti-nutritive substances hamper the digestion of such type of forages. We also have to mention the bearings of the trees of leaf-fodder provision: (acorn, wild pear, rowan, honey-locust). The nutritional content of these (Felker & Bandurski, 1977; Bruno-Soares & Abreu, 2003) is only partially explored, in spite of the century-old experiences about the higher feeding value of acorns, for example. Feeding of leaf-fodder has a long history in Hungary, since the early spring and autumn forests provided shelter for the pastors of grass-read livestock.

Ash (*Fraxinus excelsior*), elm (*Ulmus minor*) and goat-willow (*Salix caprea*), sycamore (*Acer pseudoplatanus*), and beech (*Fagus sylvatica*) is also suitable for foraging, while the foliage of oak (*Quercus robur*), linden (*Tilia platyphyllos*), poplar (*Populus tremula*), alder (*Alnus glutinosa*), birch (*Betul apendula*) is considered as poor forage.

Nutrition values of black locust (*Robinia pseudoacacia*)

The experiments in the United State have proven that the *in vitro* dry matter digestibility measurable in the leaves of black locust (*Robinia pseudoacacia*) is 66.3% in June, however during vegetation period this value decreases, reaching 53.4% by September. It is followed by a subtle increase, when digestibility grows to 55.7%. Crude protein content was 23.9% in June. This value continuously decreases, by October it was only 17%. Although nutrition content parameters deteriorate with the aging of leaves, they are still sufficient to fulfil the needs of beef cattle. Black locust can provide a good quantity of quality forage, in cases when drought forces grasses introduced vegetation (Keresztesi, 1988; Burner *et al.*, 2005).

Horton and Christensen (1981) conducted nutrition and digestibility investigations with the flour of alfalfa and black locust (Table 1.). After feeding them to sheep (Table 2), they found that the low digestibility of crude protein, organic matter and phosphor content of black locust is the main obstacle preventing the extended use of it besides alfalfa.

Table 1. Composition of Black locust and alfalfa in dry matter percentage (Horton and Christensen, 1981)

Quality traits	Black locust meal	Alfalfa flour
Crude protein (%)	**20.00**	19.80
Gross energy (kcal/g)	4.48	4.49
Ash (%)	12.00	8.80
Crude fibe (%)	13.50	24.80
ADF (%)	28.50	29.40
NDF (%)	53.60	46.30
Lignin (%)	6.40	4.90
Calcium (%)	2.70	2.13
Phosphorus (%)	0.20	0.23
Copper (mg/kg)	9.40	8.60
Zinc (mg/kg)	**42.90**	22.70
Manganese (mg/kg)	**98.60**	33.70

Table 2. Feed intake and digestibility of Black locust and alfalfa by lambs (Horton and Christensen, 1981)

Quality traits	Black locust quality	Alfalfa quality	Significance
Feed intake			
kg DM/day	1.41	1.59	NS
g/W 75 kg†	99.6	108.7	NS
Dry Matter Digestibility (%)	41.5	60.5	***
Organic Matter Digestibility	45.4	63.2	***
Crude Protein	27.0	69.6	***
Gross Energy	42.5	61.7	***
Crude Fiber	26.5	39.8	NS
ADF	0.00	38.4	**
NDF	22.2	51.1	**
Calcium	24.7	17.4	NS
Posphorous	13.0	*31.8*	**
Copper	11.2	14.8	NS
Manganese	10.4	11.1	NS

NS, ** and ***= non-significant and significant at P<0.01 andP<0.001, respectively.
†g/W 75 kg - daily total feed intake out of every kg feed, where the feed consumption was restricted to 75% of the ad libitum level.

Upon comparison (partly based on the works of Horton & Christensen, 1981) of digestibility of hand-harvested, sun-dried locust leaves and alfalfa by sheep and goats, Ayers *et al.* (1996) found, that digestibility of alfalfa is significantly higher. A possible reason for the differences is that locust leaves contain phenolic compounds (e.g. condensed tannins), which decrease digestibility of crude protein. Nevertheless, the authors of the article assess that black locust leaves can bea suitable forage.

From the works of Hui *et al.* (2004) we know that poisonous compounds can accumulate in the crust of black locust. Such compounds are robin and phasin, which stop the operation of ribosomes in a manner similar to ricin. This can cause diarrhoea and vomiting, but more severe symptoms only occur in if significant quantity of black locust crust or seeds has been consumed.

Discussion

Taking previous empirical and experimental observations into consideration, we can declare that livestock readily consume leaf-fodder both in spring and in autumn. However, laboratory experiments have proven that concerning digestible protein and fibre content, leaf-forage can only be considered as a high nutrition forage in spring

Leaf-fodder cannot be integrated into such intensive livestock farming systems as indoor dairy-cow keeping. Its feeding is worth consideration in case of semi-intensively grazed, less productive dairy cows, and also in case of heifer breeding. However, leaf-foddering could be integrated into dairy- and dual-beneficial goat keeping (Stilling *et al.*, 2017). Modern age food-quality regulations demand consistent quality, non-season-dependant nutrition values and flavour character. Certain leaf-fodders with high tannin- or fibre content can cause problems during sensory examination of milk or meat.

It can be also well fitted into integrated systems (fish-duck, rice-duck and agroforestry) as supplemental feed. It is important to take seasonal exploitation into account, since in a young, spring forest there are quite few fallen leaves. At these times animals directly graze fresh shoots and leaves, which can have long-term consequences on the growth of trees. During the summer season, humidity of the soil is high under the trees, which results in stronger grass production. In autumn, fallen leaves and yield can also serve as nutriment.

Feeding of black locust leaves can be well integrated into extensive livestock keeping and foraging systems. Such as beef cattle farming. At our present research area, limousine beef cattle are kept extensively, but for a two month period (March and

September) the livestock can also feed on black locust leaves. The underbrush vegetation can start earlier because the black locust sprouts relatively late. Due to this, before spring expulsion, the naked black locust forest with its early-sprung grass is the first place for grazing. In the following period the livestock is kept on different separated pasture sections according to the rotational grazing system. In autumn, the feeding of early-falling – due to its sensitivity to cold – black locust leaves follow. In this system, grazing season can be prolonged with approximately 1-1 months. The livestock does not cause any damage to the black locust trees, since only the lowest branches are grazed besides the fallen leaves.

Regarding the plantation of black locust and poplar, a regular concern is the water demand of these species, as well as their effect on groundwater levels. Hungarian researches (Szabo *et al.*, 2012) confirm that climate-vegetation-soil systems have a combined effect on the water content of soils. It cannot be unambiguously declared that the increase or decrease of groundwater levels is affected by the forest (or alley). These tree species typically utilize aquiferic water (Szabo *et al.*, 2018).

Conclusion

In drought years every pasture based farmer should consider supplemental feeding. Being cost effective is a real challenge. It is obvious to prolong the drought tolerant pasture vegetation with couple of weeks saving time and money until rains arrive. Foliage feeding has the benefit to keep livestock in good condition and protect it from heat.

Acknowledgement

Foremost we would like to express our thanks to Attila Micsutka for stimulating discussions and for the SzentIstvan University’s forage lab crew for the sleepless nights and support.

References

Ainalis, A. B. and Tsiouvaras, C. N. 1998. Forage production of woody fodder species and herbaceous vegetation in a silvopastoral system in northern Greece. Agroforestry Systems 42: 1-11.

Ayers, A.C. Barrett, R.P. and Cheeke, P.R. 1996. Feeding value of tree leaves (hybrid poplar and black locust) evaluated with sheep, goats and rabbits. Animal Feed Science Technology 57(1-2): 51–62.

Bajnok, M.Torok, G. Resch, R. Buchgraber, K.and Tasi, J. 2011. A termőhely, a gyeptípus és az időjárás szerepe néhány gyep hozamának alakulásában a hasznosítás intenzitásának függvényében. Gyepgazdálkodási Közlemények 2010/2011 pp. 13-18.

Bruno-Soares, A. M. and Abreu, J. M. F. 2003. Merit of Gleditsia triacanthos pods in animal feeding: Chemical composition and nutritional evaluation. Animal Feed Science and Technology 107: 151-160.

Burner, D.M. Pote, D. H. and Ares, A. 2005. Management Effects on Biomass and Foliar Nutritive Value of Robinia pseudoacacia and Gleditsia triacanthosf. inermis in Arkansas, USA, Agroforestry Systems, 65(3): 207–214.

Felker, P. and Bandurski, R.S. 1977. Protein and Amino Acid Composition of Tree Legume Seeds. Journal of the Science of Food and Agriculture 28(9): 791-797.

Gyuricza, Cs. and Borovics, A. 2018. Agrárerdészet. NAIK Könyvek, Gödöllő, 2018. ISBN 978-615-5748-05-9

Halasz, A. Tasi, J. and Raso, J. 2015. Fás legelők, legelőerdők, erdősávok és fasorok használata ökológiai gazdálkodási rendszerben. Növénytermelés, 64 (4): 77–89.

Halasz, A. Tasi, J. Bajnok, M. Szabo, F. and Orosz, Sz. 2018. Climate sensitivity of Hungarian grasslands. In: Sustainable meat and milk production from grasslands : Proceedings of the 27th General Meeting of the European Grassland Federation. Cork: Wageningen Academic Publishers, pp.: 598-600. ISBN: 9781841706436

Heap, B. 2014. Szélsőséges időjárási jelenségek Európában és hatásuk a nemzeti, valamint az uniós alkalmazkodási stratégiákra. EASAC 22. sz. szakpolitikai jelentés, MTA, Budapest 2014., ISBN 978-963-508-708-2

Horton, G.M.J. and Christensen, D.A. 1981. Nutritional value of black locust tree leaf meal (*Robinia pseudoacacia*) and alfalfa meal. Can. J. Anim. Sci., 61: 503-506.

Hui, A. Marrafa, J. and Stork, C. 2004. A rare ingestion of the black locust tree. Journal of Toxicology-Clinical Toxicology 42(1): 93-95.

Janko F., Moricz N. and Pappne Vancso J. 2010. Klímaváltozás: Tudományos viták és a társadalomföldrajz feladatai (1. rész). Földrajzi Közlemények, 134(4): 405-418.

Keresztesi, B. 1988. Black locust: The Tree of Agriculture. Outlook on Agriculture 17 (2):77-85.

Palfai, I. 2002. Magyarország aszályossági zónái. Vízügyi Közlemények, LXXXIV. évf. 3. füzet.

Penksza, K. Hazi, J. Tóth, A. Wichmann, B. Pajor, F. Gyuricza, Cs. Poti, P. and Szentes, Sz. 2013. Eltérő hasznosítású szürkemarha legelő szezonális táplálóanyag tartalom alakulása, fajdiverzitás változása és ennek hatása a biomassza mennyiségére és összetételére pannon nedves gyepben. Növénytermelés 62(1): 73-94.

Salata, D. 2009. Legelőerdők egykor és ma, A fás legelők és legelőerdők kialakulásának és hasznosításának emlékei egy öreg-bakonyi (pénzesgyőr-hárskúti) fás legelő tájtörténeti feltárásának példáján keresztül. Országos Erdészeti Egyesület Erdészettörténeti Szakosztály. Budapest. p. 80.

Stilling, F. Penksza, K.Pajor, F.Tasi, J.Halasz, A.Bajnok, M.Poti, P. and Hajnáczki, S. 2017.Kecskelegelők cönológia vizsgálatai, különös tekintettel a gyepgazdálkodási szempontból fontos növénycsoportokra és cserjék előfordulására pp. 280-281., 2 p. In: Kerényi-Nagy, Viktor; Gyuricza, Csaba; Estók, János; Mezőszentgyörgyi, Dávid; Lakatos, Tamás; Posta, Katalin; Penksza, Károly (szerk.) II. Rózsa- és galagonyakutatás a Kárpát-medencében. Konferencia-kötet : 2nd Rose- and hawthorn research in Carpathian Basin. Proceedings-book. Gödöllő, Magyarország : Szent István Egyetem Egyetemi Kiadó, 2017) p. 283.

Szabo, A. Gribovszki, Z. Jobbagy, E. G. Balog, K. Bidlo, A. Toth, T. 2018. Subsurface accumulation of $CaCO_3$ and Cl^- from groundwater under black locust and poplar plantations. Journal of Forestry Research 29 (3) DOI: 10.1007/s11676-018-0700-z

Szabó, A. Kiss, K. Gribovszki, Z. and Toth, T. 2012. Erdők Hatása A talaj és altalaj sóforgalmára, valamint a talajvíz szintjére. Agrokémia és Talajtan 61 (1): 195-209.

Szemethy, D. Orosz, Sz. and Szemethy, L. 2012. Investigation of nutrient content and fermentation of different foliage silages. Review on Agriculture and Rural development, (1): 434-439.