The traditional agrosilvopastoral valonia oak systems in Kea island - Greece: productivity and ecosystem services

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Abstract

One of the most distinctive valonia oak agrosilvopastoral system in Greece is found in the Aegean island of Kea - Cyclades. Agriculture is not easily practiced in the island due to the xerothermic climate and the rough terrain with steep slopes, rending agrosilvopastoralism with valonia oak an ideal option to support the local economy and preserve the environment. Actually, the characteristic terraces of the island, constructed by the locals since ancient times, are a reference point for the character and economy of the island. These systems are nowadays threatened by abandonment and change of land use (mainly for touristic purposes) endangering by loss of the traditional activities and environmental functions. In a meeting that was organized under the framework of the AGFORWARD (FP7) research project, local stakeholders of the island expressed their interest for the multiple products and uses that this system provides. Based on their suggestions, an experiment was conducted in a traditional system of the island. Two commercial pasture mixes were tested for their productive capacity under shade. Species composition and biomass production were recorded for two years. Shading by valonia oak affected biomass production from both commercial mixtures. The importance of the environmental and economic function of this system is highlighted and suggestions are made for its preservation.

Keywords: Agroforestry, agrosilvopastoral system, Mediterranean region, *Quercus ithaburensis* subsp. *macrolepis*

1. Introduction

Valonia oak (*Quercus ithaburensis* subsp. *macrolepis* (Kotschy) Hedge & Yalt.) is a tree species which is closely related to the physiognomy, history and economy of the island of Kea. It appears mainly in the central and eastern side of the island in an area of 2,000 ha as stands, small thickets and groups as well as in an area of 1,000 ha as very open woodlands or isolated trees (Pantera 2001; Pantera and Papanastasis 2003; Pantera *et al*. 2008). The presence of valonia oak in the Island of Kea is the results of its natural distribution in the islands and the coast of the Aegean sea (Tutin *et al*. 1993; Strid and Tan 1997), but could have been planted in the past for agricultural purposes. Almost all the land with valonia oak trees is private and characterised as silvopastoral or agrosilvopastoral systems, included in the oak tree agroforestry systems of high natural and cultural value (Der Herder *et al*. 2015), combining agricultural, forest and livestock production, using traditional agroforestry practices. Most of these areas are formed in terraces as it is common in most Aegean islands, due to the steep terrain. Agrosilvopastoralism is a main land use system on Kea island which is practised today by only few local farmers. In the past, the valonia oak trees used for collecting cups for tanneries. Furthermore, from pruning the mature trees, which was performed mainly for the production of acorns, firewood was also collected for household use and charcoal. Parts of the fields with valonia oak trees with more fertile soils were cultivated with grapes, almonds trees and periodically by cereals and other forage plants to produce marketable crops and supplementary fodder for the animals that can be used in winter period. Livestock mostly composed of sheep, goats and less from cattle and pigs simultaneously grazed these areas with time limitations to those that could be cultivated. The abandonment of these traditional uses, and mainly that of acorns harvesting in the mid 70's, led to the depreciation of valonia oak. Many traditional fields with valonia oak trees and livestock farming systems were abandoned resulting to their forestation and encroachment. In other occasions they have been converted to summerhouses and tourist resorts due to the high value of the land for this uses.In the last decade, there has been an effort in the island to recover these uses as an attempt to revive agricultural economy as well as for ecological purposes, as in other regions with valonia oak woodlands (Pantera *et al*. 2015). In this direction, local initiatives in Kea Island launched the collection of acorns for using the acorn cups in leather tanning and the nuts for the production of flour for human consumption. In the period 2011-2015, 82.4 tons of acorn cups were exported from Kea to Germany and India or used in Greece and 10.3 tons acorn nuts used locally for flour production (Mayer M., personal communication). It should be noted that during the decade of 1940's, the annual acorn cups production, all exported from the island to the various European countries, reached 1,923 tons (Diapoulis 1939). Additionally to the acorn collection, there have been some efforts to promote organic farming and livestock grazing for the production of high quality local products but also for the promotion of the ecological values of valonia oak in the island (Pantera 2014a,b). During a stakeholders' meeting that was organized under the framework of the AGFORWARD (FP7) research

project (Pantera 2014b), local stakeholders of the island expressed their interest for the multiple products and uses that this system provides. With this in mind and taking into account that the main use of most valonia oak silvopastoral - agrosilvopastoral systems is grazing, it was decided to thoroughly study the forage productivity and the effect of tree shading on grass growth and development. The question to be investigated was to increase of fodder autonomy of the farms and pasture productivity and quality increase. The main purpose of this research was to examine a) the possible relation of trees to biomass productivity of different legume species, b) the valonia oak shading effect on understorey grass biomass and generally the other ecosystem services.

2. Material and Methods

The experimental site was located in a representative of the Kea island private farm (agrosilvopastoral system) in Kato Meria, in the North-east of the Kea island of Cyclades (Aegean see), with coordinates: 37°34'48"N, 24°19'32" E, altitude 380 m a.s.l. (Figure 1).

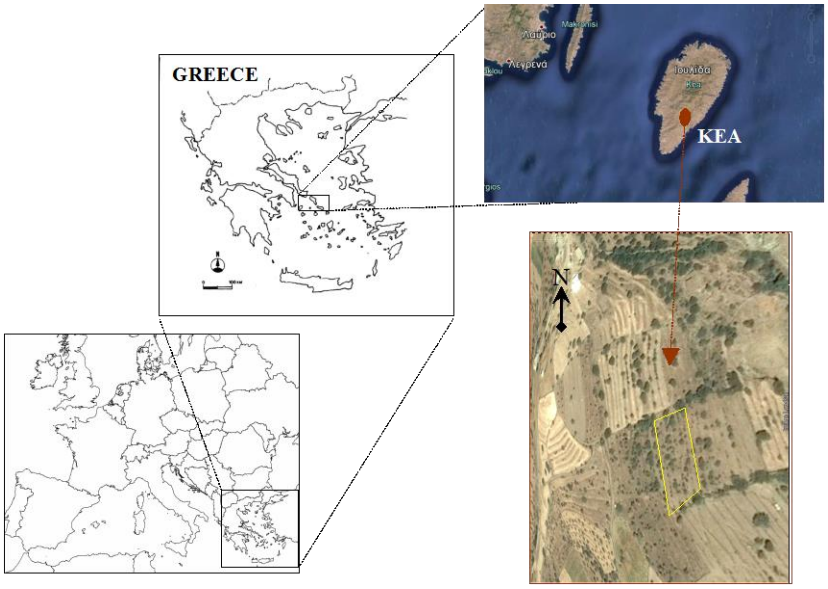

Figure 1. Map and satellite images from Google Earth of Kea island showing the position of experimental site of valonia oak agrosilvopastoral system.

The farm size is 0.5 ha approximately with its entire surface formed in terraces. Slope inclination ranged from 35-45 % with a SE exposure. The principal activity of this farm is livestockraising composed mostly of sheep and goats (stocking density 5-8 LU per ha^{-1}) and the periodical cultivation in some terraces of cereals and oats. According the data of the local meteorological stations and the nearest in Kea Island stations of Lavrio and Karistos, the mean annual precipitation calculated 479 mm, and the mean annual temperature 18 °C. The soil type (WRB classification) is cambisols, with depth ≤1 m and pH 6.65. In the field there are, most probably artificially, planted valonia oak trees in lines at the edges of the terraces, over approximately 80-100 years old, with density 10-40 trees ha^{-1} and ground cover 20-30 % and natural grass with ground cover 90-100%.The experiment was established in an area of 0.12 ha. Within the field 30 experimental plots 1χ1 m were randomly selected, witch includes natural grassland and two commercial mixtures including up to nine forage legume species. One is a mixture commercialized by the company Fertiprado (60.6%*Trifoliumsubterraneum*, 4.5% *T. michelianum* var balansae, 3% *T. vesiculosum*, 3% *T. resupinatum*, 6.1% *T. incarnatum*. 1.5% *T. istmocarpus*, 1.5% *T. glanduliferum*, and 19.7% *Ornithopussativus*) and one is a mixture provided by ISPAAM (40% *Trifolium subterraneum* cv Campeda, 40% *Medicagopolymorpha* cv Anglona, 10 % *Loliumrigidum* cv Nurra). For each treatment there were selected similar shaded and open to natural light positions. Both mixtures were fertilized with 144 kg ha^{-1} of monopotassium phosphate 0-52-34 before seeding. The experimental plots were fenced for protection from grazing. The planned measurements to be taken in the treatments are the relative abundance per species and per microhabitat, expressed in terms of green biomass and the average height and density of plants within the squares. Plants sampled at maturity end May in 50 cm x 50 cm square placed in the middle of each plot. All living biomass within the square were harvested and stored in carton bag, transported to the laboratory and refrigerated at +5°C. The following day the plant species were botanical separated and placed into furnaces to be dried at 56°C until steady weight. After drying the samples were weighed per species and dry weight was calculated as Kg/ha.

3. Results - Discussion

From the analysis of the total dry biomass per treatment it appears that in 2016 the sown with the two commercial seed mixtures with high number of self-reseeding legume species have no statistical increase in forage biomass. However, shading favoured production for both cultivars (seed mixtures) as compared to the ones growing in the

open (Fig. 2). This effect of shading was not noted for the natural vegetation. The enhanced production in the shaded locations may be mainly attributed to the increase of legume cover and biomas and, mostly, of *Trifolium subterraneum*. On the contrary, no statistically differences were noted on pasture productivity of the cultivars or for the shaded and open to natural light positions for 2015 (Fig. 2). The greatest production in all treatments of 2015 compared to 2016 is attributed to its higher precipitation during the spring period.

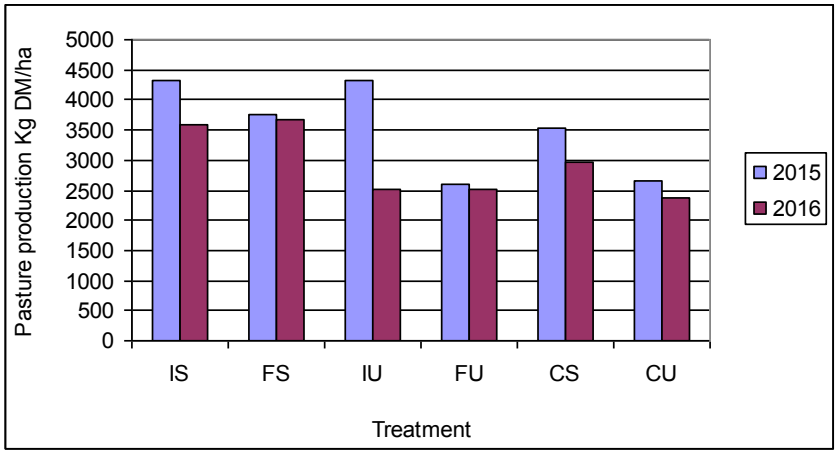

Figure 2. Mean pasture production per treatment for the years 2015 and 2016 (IS=ISPAAM Shaded, IU=ISPAAM Unshaded, FS=FERTIPRADO Shaded, FU=FERTIPRADO Unshaded, CS=Control Shaded, CU=Control Unshaded)

The positive effect of tree shading onto the two commercial seed mixtures experimentally tested within the framework of the AGFORWARD project but also in other Mediterranean oak silvopastoral systems (Moreno *et al*. 2015; Franca *et al*. 2015), indicates that they can be used for the improvement of valonia oak pastures in the Island of Kea. Tree shading resulted to a slight increase in forage quality due to increased clover biomass. This, further contributed to the protection and improvement of the field by numerous regulating and other ecosystem services (Jose 2009; Moreno *et al*. 2016) provided by the trees. The cover of the soil by the large canopy of valonia oak trees and the position of the trees on the edges of farmland terraces in the examined agrosilvopastoral system, they provide protection against soil erosion, and help groundwater recharge and quality protection. Concerning the supporting services and biodiversity, the valonia oak trees provide shelter to wildlife contributing to the conservation of the ecosystem biodiversity and forage and shade for livestock during the summer period.

4. Conclusions

Shading from valonia oak tree canopy favored production of undergrown pasture species in the commercial seed mixtures with species rich in legumes, compared to the ones growing in open light. This indicates that these commercial mixtures can be used for the improvement of xerothermic grasslands with valonia oak widely present in the island of Kea. The presence of trees, not only cannot be considered as hindering pasture production but positively contribute and provide numerous ecosystem services which are necessary for the protection and better functioning of valonia oak agrosilvopastoral systems in the island of Kea.

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