Environmental effectiveness of the cross compliance Standard 4.6 'Minimum livestock stocking rates and/or appropriate regimens'

Lucia Sepe,[1] Mauro Salis,[2] Rosa Francaviglia,[3] Marco Fedrizzi,[4] Antonio Melchiorre Carroni,[2] Emilio Sabia,[1] Annarita Bruno,[1] Domenico Rufrano,[1] Paola Ruda,[2] Maria Teresa Dell'Abate,[3] Alberto Alianello,[3] Marco Veloccia,[3] Olimpia Masetti,[3] Gianluca Renzi,[3] Roberto Fanigliulo,[4] Mauro Pagano,[4] Giulio Sperandio,[4] Mirko Guerrieri,[4] Daniele Puri,[4] Salvatore Claps[1]

[1]CREA-ZOE Council for Agricultural Research and Economics, Research Unit for Extensive Animal Husbandry, Bella (PZ)
[2]CREA-AAM Council for Agricultural Research and Economics, Research Unit for Agro-pastoral Systems in Mediterranean Environment, Sanluri, Medio Campidano (VS)
[3]CREA-RPS Council for Agricultural Research and Economics, Research Centre for Soil-Plant System studies, Roma
[4]CREA-ING Council for Agricultural Research and Economics, Research Unit for Agricultural Engineering, Monterotondo (RM), Italy

Corresponding author: Lucia Sepe
E-mail: lucia.sepe@crea.gov.it

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Abstract

The paper presents the main results of the monitoring on the effectiveness of the cross compliance Standard 4.6 'Minimum livestock stocking rates and/or appropriate regimes' carried out in two case studies within the MO.NA.CO. Project: sheep grazing in medium-rich pastures in southern Apennines and in the plain of Sardinia, Italy. The monitoring involved aspects related to soil, flora, livestock and economics (competitiveness differential). The study showed, although in the short term, that the minimum stocking rate 0.2 LU/ha/year was not effective and, conversely, the effectiveness of the maximum level of stocking rate (Livestock Unit, LU; 4 U/ha) for the maintenance of the habitat. The generalization in applying minimum and maximum rate, not taking into account the climatic conditions, forage resources or farming system (including the species of grazing animal) may lead to a serious nullification of the conditions of the Standard. The authors recommend to identify homogeneous areas and eligible specific stocking rates from all Italian regions, also considering the animal species.

Introduction

The CAP reform of June 2003 requires the Member States to make sure that any decrease in permanent pasture area (the percentage of total agricultural area) does not occur. The EC Reg. No. 796/04 (as amended) sets in art. 2 the following definition of permanent pasture 'land used to grow grasses or other herbaceous forage naturally (self-seeded) or through cultivation (sown) and that has not been included in the crop rotation of the holding for five years or longer, excluding land under set-aside…'. The Standard 4.6 was intended as a measure to avoid the grassland degradation, and imposes a range of stocking rates per hectare per year [minimum 0.2, maximum 4 LU (Livestock Unit), respectively].

that responds to various scenarios. Below and above these limits, the legislator foresees situations of under- and over-grazing, likely to cause damage to the habitat. This measure is intended to preserve the pastoral areas in the EU territory of some ecological interest and is distinct from cross-compliance: individual farmers are required to keep a specific area of permanent pasture in their farms. In the event that the national/regional percentage of permanent pasture decreases significantly, the Member State must adopt measures addressed to farmers, such as forcing to keep (or at worst to restore) the part of existing permanent pasture in their farms.

In a recent study carried out in Italy on the effectiveness of the standard cross-compliance on stocking rate, Sepe *et al.* (2011) have pointed out that the measures adopted by the European Council aimed to avoid, for example, a massive conversion to arable crops. In mountain pastures, spatial variation of grazing pressure caused by the heterogeneous dispersion of livestock contributes to the creation of a mosaic of vegetation characterized by high biodiversity of flora and invertebrates, which are vital for the maintenance of many ecosystem functions (Dumont *et al.*, 2007). Misuse of grazing can affect the balance of the whole system. In particular, from a livestock standpoint, overload or under-load can lead to important consequences: i) decrease in productivity and quality degradation of the sward, which may impair the future recovery of the same degraded resources; ii) a significant increase in necrotic biomass*, i.e.* composed of not used and dry plant material, which reduces the penetration of sunlight in the lower layers of the turf, operating a negative pressure against plant biodiversity, with the reduction in the long term in the number of herbaceous species in the sward; iii) prevailing of unpalatable species and cause of degradation in the sward; secondary succession in the long term, with the disappearance of open pasture due to the windward firstly degradative herbaceous species, then bushy and arboreal. Finally, it is essential also the turnover of grazing animal species. In fact, as demonstrated by several authors, the species show different grazing behaviour, not only for the amount of biomass removed, but also for the way of browsing and the pressure they exert on the soil per unit of area (Potenza and Fedele, 2011). The stocking rate per hectare required by Standard is expressed in LU/ha, equivalent to 6.7 adult sheep, which do not cause the same effects of one adult bovine on the pasture.

Decline in pasture biodiversity can lead to a loss in the operation of production and/or absorption of nutrients (and other bio-geochemical cycles). When the grazing activity is managed with rational criteria, it can play an important role in conserving biodiversity by helping to preserve these habitats at risk of impoverishment (Bornard *et al.*, 1996). Concerning soil related aspects, no indicator can fully characterize the agro-ecosystem status if considered singularly. However, soil organic matter content (SO) correlates with many aspects of agro-ecosystem productivity, sustainability, and environmental integrity (Smith *et al.*, 2000). In general, SO content is positively correlated with a positive soil status, and plays a mostly beneficial role in determining the physical, chemical and biological qualities of a soil, the ecosystem functioning, and the magnitude of the different processes. In addition, SO varies among environments and management systems, and generally increases with higher mean annual rainfall (Burke *et al.*, 1989) and lower mean annual temperatures (Jenny, 1980); with higher clay content (Nichols, 1984); with an intermediate grazing intensity (Parton *et al.*, 1987; Schnabel *et al.*, 2001); with higher crop residue inputs (Franzluebbers *et al.*, 1998); with native vegetation compared with cultivated management (Burke *et al.*, 1989; Francaviglia *et al.*, 2014); with conservative tillage compared with plough tillage (Rasmussen and Collins, 1991; Farina *et al.*, 2011). According to Conant and Paustian (2002), soil organic carbon may decline if inputs decrease due to decreased net primary production as a result of overgrazing. Soussana and Lemaire (2014) have stated that at low stocking density, grazing enhances soil N cycling and net primary productivity, leading to an increased soil carbon sequestration, which however declines at high stocking density. As a consequence, changes in grassland management which reverse the process of declining productivity may lead to increased soil organic carbon. Moreover, both organic carbon and soil microbial biomass carbon are higher under grassland compared to cropland and overgrazed land (An *et al.*, 2009). No data comparing the effect of grazing intensity on soil organic carbon and biological fertility are actually available for a same monitoring site. In accordance to the economic aspect, to adhere to the Standard the farmer can conform the stocking rate by decreasing the number of heads or, with the same heads, by increasing the area to be used for pasture. The competitiveness gap aims to compare in economic terms the convenience of a production system in comparison to another by changing the value of some parameters and considering the cost items of the farm.

The aim of this monitoring was to verify, in two case studies of the sheep grazing system, the effectiveness of the Standard 4.6 of Cross-compliance, by comparing the two limits of the Standard with a case of overgrazing (6 LU).

Figure 1. Location of CREA - ZOE and AAM monitoring sites.

Materials and methods

Two case-studies have been monitored in Italy, in two experimental farms afferent to the CREA, as representative of the sheep grazing system: the Southern Apennines and the Sardinian lowland, without ambition of generalization of the Italian system (Figure 1).

Farms and stocking rates

Southern Apennines - CREA-ZOE - Li Foy (Potenza, Italy), north-west of Basilicata Region (40° 37' N, 15° 42 'E; 1,230 m asl), included in the list of the Sites of Community Importance of the Mediterranean biogeographical region (IT9210215). The soil is of volcanic origin with signs of ancient flood events, with a clay-loam texture and deep. The area, at permanent natural pasture, is used by sheep and goats over 25 years. Three paddocks were used, each of them with a different stocking rate: 0.2 LU/ha (F1), 19,000 m^2; 4 LU/ha (F2), 7200 m^2; 6 LU/ha (CF), 10,000 m^2 (divided into two semi-paddocks). Gentile breed mature sheep were used, dry or pregnant, in homogeneous groups by age and weight. The grazing season generally began in May; it ended in August in 2012, while in 2013 and 2014 it ended in September. The animals grazed for about 8 h/day, with night shelter indoor (model of continuous grazing). When finished the biomass from pasture (in CF), polifita hay and concentrate supplementation were supplied.

Sardinian lowland - Farm settled with CREA-AAM. Located in Baratzu, Arbus (VS), sub-lowland area, south-eastern of Sardinia Region (39° 30' N, 8° 36' E, 200 m asl). The soil has a sandy-clay-loam texture with a medium depth. The area, at permanent pasture, has been used for over ten years with dairy Sarda sheep breed. Three paddocks were used, with the same three stocking rates: 0.2 LU/ha (F1), 15,000 m^2; 4 LU/ha (F2), 3000 m^2; 6 LU / ha (CF), 2500 m^2. In the paddocks, shelters were made for the night and livestock was left grazing for 24 hours. The grazing season began in December 2012 and ended in December 2013, with only one break in April-May 2013, due to excess of stagnation in the field for persistent rains. The feeding of sheep in area F1 consisted exclusively in herbage from pasture, while in F2 and CF after a few months, due to the herbage shortage, animals were fed alfalfa hay and concentrate supplementation.

Soil organic matter and biological fertility

Soil organic matter content (SO) is commonly determined indirectly by multiplying the total soil organic carbon concentration (TOC) by the Van Bemmelen conversion coefficient (1.724) reported by Jackson (1965), based on the assumption that the content of organic carbon is 58% of soil organic matter. Therefore, in this work soil organic carbon will be considered. The biological fertility has been studied through the calculation of a comprehensive indicator (IBF), which allows the comparative evaluation of the different treatments with some analytical parameters determined in standard laboratory conditions (Benedetti *et al.*, 2006; Benedetti and Mocali, 2008; Francaviglia *et al.*, 2015). Six key parameters are considered: total soil organic matter (SO), microbial biomass carbon (Cmic) (Vance *et al.*, 1987), basal respiration (Cbas) and cumulated respiration (Ccum) (Isermeyer, 1952), metabolic quotient (qCO_2), given by (Cbas/Cmic)/24*100 (Anderson and Domsch, 1990; 1993), mineralization quotient (qM), expressed as Ccum/TOC*100 (Dommergues, 1960).

CREA-ZOE farm. The soil samplings carried out in 2010 during the previous project EFFICOND have been considered as the zero point of the monitoring; the final soil sampling has been carried out at the end of 2014 (three replicates in each plot) at two depths (0-20 and 20-40 cm).

CREA-AAM farm. Soils have been sampled at the beginning and at the end of the grazing season (three replicates in each plot) at two depths (0-20 and 20-40 cm). The final soil sampling has been carried out at the end of 2014.

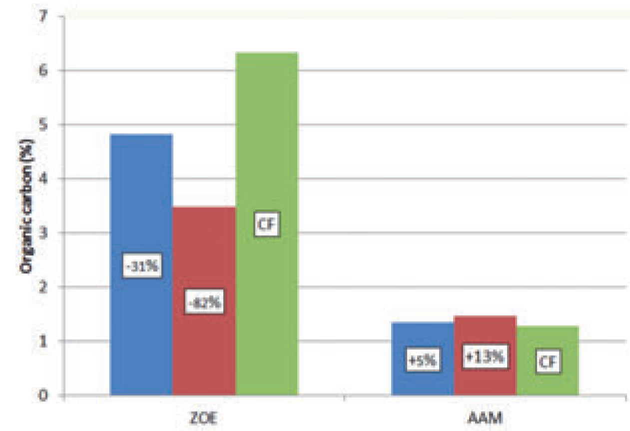

Figure 2. Soil organic carbon at the two monitoring sites (0-20 cm).

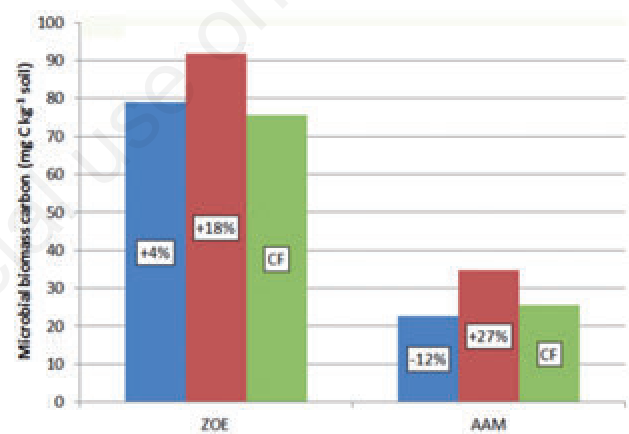

Figure 3. Soil microbial biomass carbon at the two monitoring sites (0-20 cm).

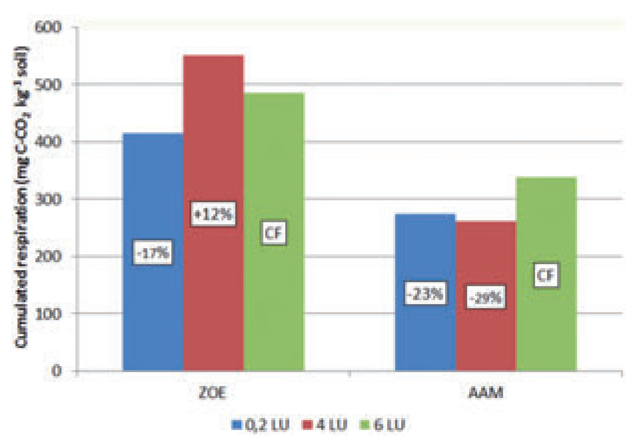

Figure 4. Cumulated soil respiration at the two monitoring sites (0-20 cm).

Botanical bio-diversity

The floristic surveys were performed by visual assessment of the families present and divided into Grasses, Legumes, Others, palatable and unpalatable plants, thorny species, bushy species (expressed in % of coverage), percentage of dry grass (standing hay) and bare soil (Sepe *et al*., 2015). The species recognition was also carried out within and outside the homogeneous areas: Compositae, Boraginaceae, Dipsacaceae, Euphorbiaceae, Iridaceae, Plantaginaceae, Ranunculaceae, Scrophulariaceae and Umbelliferae families, within Others.

CREA-ZOE farm. In the paddocks, 2 or 3 homogeneous areas were found (three in F1 and CF, two in F2); within them, an area 1 x 1 m sized, just delimited by 4 wooden posts to enable regular grazing by animals and studying a condition close to reality, was chosen. The surveys were carried out monthly on floristic composition and dry matter production (DM). Grass samples were collected for qualitative analysis.

CREA-AAM farm. Each paddock was divided into homogeneous areas (three in F1, F2 and one in CF) and in each of them two exclusion areas 1 m^2 size were arranged; the vegetation composition and production were assessed and measured. The surveys were performed at the beginning and at the end of the grazing season every year.

Biomass production and quality

The DM production per ha was evaluated by mowing the vegetation in an area bounded by a metal square 1 x 1 m sized, near to the homogeneous areas, on the days of survey (Sepe *et al*., 2015); for the evaluation of DM percentage, a sample of 400-600 g was placed in a ventilated oven at 60° C until constant weight was reached and then ground (Cyclotec Tecator mill, grid of 1 mm); DM production per ha was calculated by applying the DM % to the total grass mowed in 1 m^2. A sub-sample of herbage was used for the following qualitative determinations: Crude Protein (CP), Ethereal Extract (EE), Ash (AOAC, 1990), Crude Fibre (CF) (Martillotti *et al.*, 1987) and its fractions Neutral Deterged Fibre (NDF), Acid Deterged Fibre (ADF), Acid Deterged Lignin (ADL) (Van Soest *et al.*, 1991) (Ankom 200 Fiber Analyzer - ANKOM Technology Corporation, Macedon, NY, USA).

Animal monitoring

At the beginning and at the end of the three years grazing season the live weight was recorded and the body evaluated by Body Condition Score method (BCS) (Fedele, 1996). The wool was shorn in July and weighted.

Competitiveness gap

To calculate the economic competitiveness gap, the direct and indirect costs incurred by the farmer were taken into account to adapt the stocking rate within the legal range, excluding the possibility of reducing the number of animals. It has been hypothesized the case of non-adherence with a stocking rate 6 LU ha^{-1} year^{-1}: to reduce the rate up to 4 LU ha^{-1} year^{-1} the grazing area would increase by 1.5 fold, while to reduce it to 0.2 LU ha^{-1} year^{-1}, the surface should increase by 30 fold. For each hypothesis, the farmer has to integrate the natural feed from grazing with the hay purchased on the market at an average price of 0.14 € kg^{-1}. Reducing the stocking rate from 6 to 4 LU ha^{-1} year^{-1}, as it increases the availability of pasture herbage, it also reduces the annual need for hay. In case of a reduction from 6 to 0.2 LU ha^{-1} year^{-1}, this integration will be even lower because the availability of pasture will be significantly higher.

In this context, we considered three types of quality of pasture (rich, medium and poor), in function of which we have estimated different needs of hay (Table 1). The annual intake of concentrate supplementation was considered constant in both cases, amounted to 40 kg head^{-1} at a cost of € 0.31 kg^{-1}, given in 100 days during the year (end of ges-

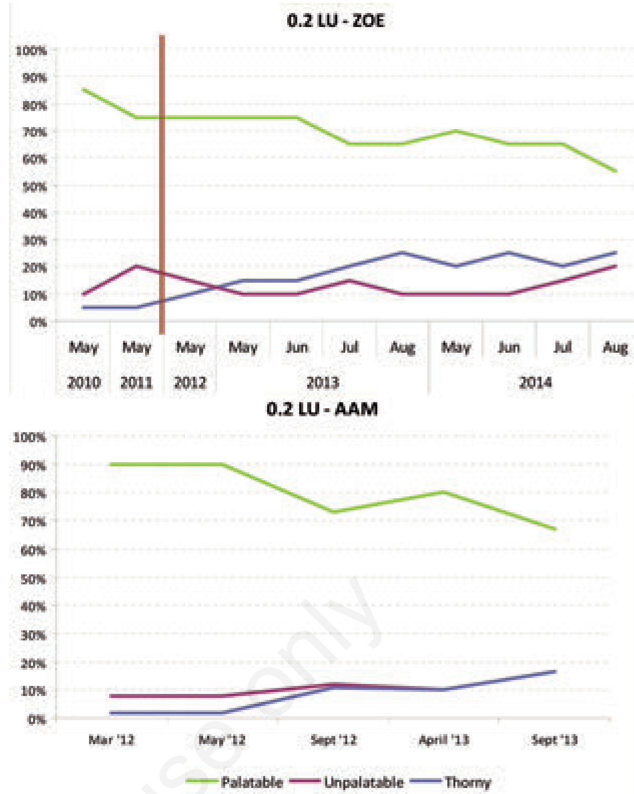

Figure 5. Variation of botanical composition from 2010 to 2014 in paddocks with stocking rate 0.2 LU/ha, ZOE, Li Foy (a) and AAM, Arbus (b) farms.

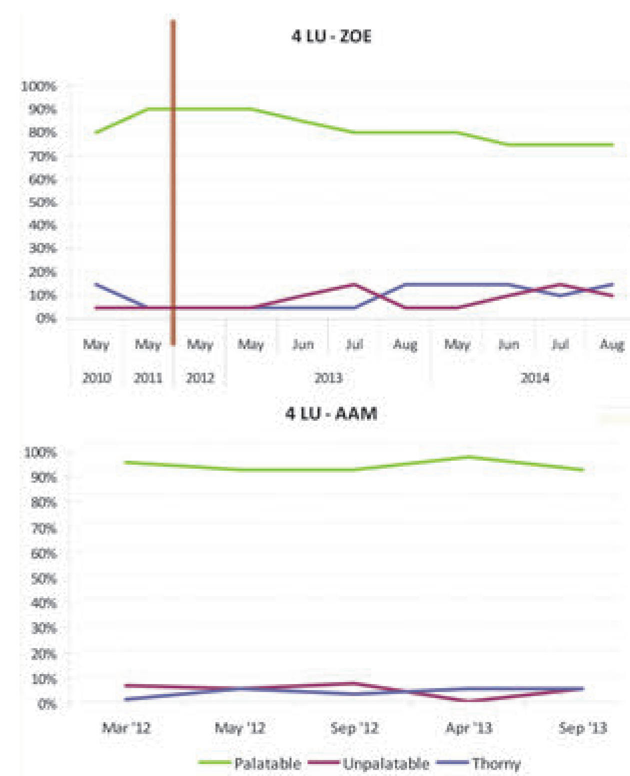

Figure 6. Variation of botanical composition in paddocks with density 4 LU/ha, ZOE, Li Foy (a) and AAM, Arbus (b) farms.

tation, lactation and preparation for mating). In calculating the economic competitiveness gap all the other elements of cost (more downtime due to movements of animals for grazing on large areas, *etc.*) were not considered. The rent fee varies considerably if public land (state-owned) or private. Sometimes they are granted free of charge, other times with variable cost: the *fida* pasture for public lands varies on average from 30 to 50 € ha^{-1} $year^{-1}$, also according to pasture quality. There is great uncertainty in the determination of the fees for private land, it can range from zero (free concession in return for the control of wild flora and soil fertility), up to amounts that exceed 3-4-fold than those of *fida* pasture. The fee is paid cash or bartered (cheese, lambkid, *etc*.). For this reason it has been considered a simulation scenario with a cost ranging from 0-150 € $ha^{-1}year^{-1}$. The economic competitiveness gap was established on the basis of the difference between the total cost of feeding and rent incurred in the two cases of the standard (4 LU ha^{-1} $year^{-1}$ and 0.2 LU ha^{-1} $year^{-1}$), compared to the same total costs calculated in the case of non-adherence to the Standard (6 LU ha^{-1} $year^{-1}$). Negative values indicate that there is an economic advantage in the moving from the non-adherence to the limit of the Standard, while positive values indicate an economic loss determined by costs increasing.

Results

Soil organic matter and biological fertility

CREA-ZOE farm. Soil organic carbon content at the end of monitoring was 4.82, 3.48 e 6.33% in the 0.2, 4 and 6 LU plots respectively. The effectiveness in the plots with the two stocking rates F in comparison with the overgrazing rate (CF), given by (F-CF)/F*100, was negative and equal to -31 and -82 % respectively (Figure 2). The lower soil organic carbon content in the 4 LU plot could be attributed to the different soil grain size distribution. In fact, even if textures were always clay-loam, the 4 LU plot showed a 12-15% lower silt content, and a 9% higher sand content. Hence, in these conditions the soil organic matter was less protected by the processes of chemical stabilization mediated by the silt + clay fraction, which express the soil ability to retain the soil carbon by its association with silt and clay particles. Moreover, a lower silt and clay content resulted in a lower formation of soil aggregates which physically protect the carbon by forming physical barriers between microbes and their substrates (Six *et al.*, 2002). Among the parameters included in the biological fertility index (IBF), determined in the samples of 2013, the microbial biomass carbon (Cmic) and the cumulated respiration (Ccum) were indicators of a higher microbial activity in the 4 LU plot. In fact, the effectiveness of the two factual treatments in comparison with the nonfactual plot was +4 and +18% for Cmic (Figure 3), -17 and +12% for Ccum (Figure 4).

CREA-AAM farm. Soil organic carbon content at the end of monitoring was 1.34, 1.46 e 1.28% in the 0.2, 4 and 6 LU plots respectively. The effectiveness of the two regulatory stocking rates F (0.2 and 4 LU) in comparison with the CF (6 LU plot), given by (F-CF)/F*100, was positive and equal to +5 and +13% respectively (Figure 2). Among the biological fertility parameters, only the microbial biomass carbon Cmic has indicated a better soil quality in the 4 LU plot, with a positive effectiveness equal to 27% (Figure 3).

The results from the two farms partially confirmed what previously reported in the introduction, in fact the 0.2 and 4 LU grazing intensity were not able to preserve the organic carbon content in the surface soil layer. With a high stocking rate (6 LU), higher organic inputs from the grazing herds would be returned to the soil that, in the case of the CREA-ZOE farm, would be able to contrast the lower inputs from crop residues originated from the turf degradation. Probably, considering the animal species used during the monitoring (sheep), 6 LU could not represent an overgrazing condition for the soil organic carbon. When considering the biological fertility, the 4 LU plot showed higher values in comparison with the 6 LU plot, mainly in terms of soil microbial biomass. No definitive conclusions can be derived concerning this Standard for this parameter considering the short period of monitoring.

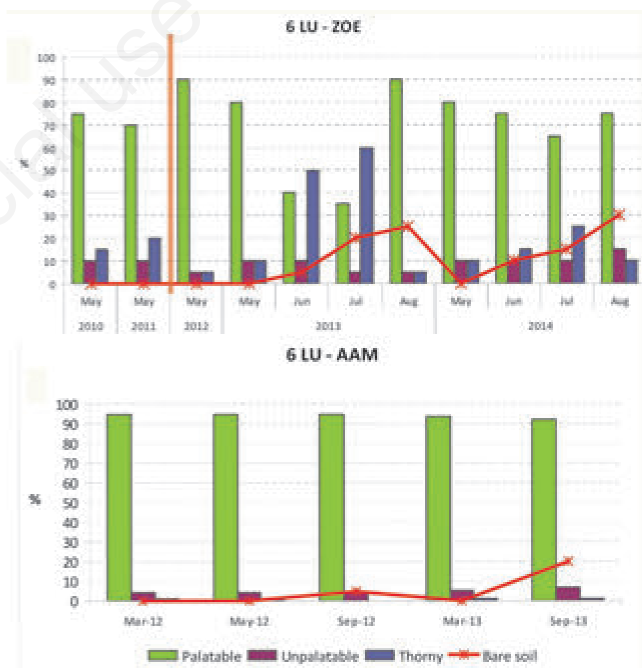

Figure 7. Variation of botanical composition and bare soil in paddocks with density 6 LU/ha, ZOE, Li Foy (a) and AAM, Arbus (b) farms.

Table 1. Consumption and expense for the purchase of hay in relation to the quality of pasture.

Quality of pasture	Consumption of hay (kg $year^{-1}$ $head^{-1}$) 6 LU ha^{-1} $year^{-1}$	4 LU ha^{-1} $year^{-1}$	0,2 LU ha^{-1} $year^{-1}$	Annual cost of hay (€ $year^{-1}$ $head^{-1}$) 6 LU ha^{-1} $year^{-1}$	4 LU ha^{-1} $year^{-1}$	0.2 LU ha^{-1} $year^{-1}$
Rich	710	648	297	99	91	42
Medium	947	864	396	133	121	55
Poor	1065	972	446	149	136	62

Botanical bio-diversity

The results are presented within each stocking rate as a comparison between the two case-studies.

Plot F1 (0.2 LU/ha). From the graph (Figure 5a) it can be observed for the ZOE farm a decreasing trend over time in the percentage of Palatable compared to unpalatable and Thorny species, that grow proportionally. The presence of about 85% of Palatable refers to a previous period, when the plot was grazed by goats with 2.4 LU/ha/year stocking rate (optimal for the potential of the pasture). Among the unpalatable species, the buttercup dominated (*Ranunculus bulbosus*, stagnation species), only at the beginning of grazing season. Among the Thorny species, thistles increased from rare plants up to >20%; moreover, the bland action of the three grazing sheep led to the onset of a secondary succession: increase in hawthorn and *Ononis spinosa*, up to 20-25% at the end of monitoring. Necrotic biomass (dry grass, high, technically called 'standing hay'), not grazed by sheep in previous years, in May has increased from 30% (in 2012) to 40% (in 2014) of total available biomass. Similarly, AAM farm showed a gradual decline of the Palatable species in the F1 plot (Figure 5b). Palatable species, preponderant at the beginning of monitoring (90-95%), decreased to nearly 60% of plant species. The relationship between Grasses and Legumes (around 70/30) within palatable species did not change. By contrast, both unpalatable and Thorny species increased significantly up to almost 20%. Among the unpalatable species, the most abundant was *Asphodelus* L., among the thorny species, Milk Thistle and *Cynara cardunculus* var. *sylvestris*.

Plot F2 (4 LU/ha). The situation in ZOE farm at the beginning of monitoring in May 2012, is the effect of sheep grazing with 2.1 LU/ha (Figure 6a). The majority of Palatable species (30% respectively for Grasses, Legumes and Others) left something less than 5% to Thorny (thistles) and 5% unpalatable (ferns) species, located mostly to the edge. After the first period, the percentage of Unpalatable and Thorny species showed overall stability, settling on 10 and 15% respectively. A similar trend was observed in AAM farm (Figure 6b), where all classes of species did not suffer percentage variations in the two years of observation. Palatable species, always present around 90-95%, at the beginning of monitoring consisted in Grasses, Legumes and Other species in the ratio of 75/5/20. At the end of monitoring this ratio changed to 65/25/10, then with a significant increase in legume species to the detriment especially of Others. As in the 0.2 LU/ha plot, thistles and asphodels were the prevalent species among thorny and unpalatable, respectively.

Plot CF (6 LU/ha*)*. The 6 LU plots showed the same trend *i.e.* decrease in Palatable specie and increase in the percentage of bare soil at the end of the monitoring. In fact, in ZOE farm (Figure 7a) it was observed a drastic drop of the Palatable species in summer (July and August), when the availability of biomass has dropped to almost zero, while AAM farm showed a slight decrease in Palatable species in the second year, although remaining nearly constant Thorny and Unpalatable species (Figure 7b). Among the last class, the asphodels dominated, increasing from no more than 5% of the surface to 15%, even when consumed at the floral top and as dry leaves. The ratio among Grasses, Legumes and Others on May, in the first and last year of monitoring, changed from 40/20/40 to 35/40/25, with a noticeable decrease in biodiversity. The proportion of legumes in the pasture decreased from 20% at the beginning of monitoring (*Medicago polymorpha* and *Trifolium subterraneum*) to 15% (*Trifolium subterraneum* only). The grasses decreased (75-60%) with the disappearance of *Bromus hordeaceus*. At the end of monitoring, the percentage of bare soil surface, *i.e.* without vegetation, showed a significant increase, reaching 30% and 20% for ZOE and AAM respectively, corresponding to the decreasing trend of Palatable species.

The percentage decrease in Palatable species in 0.2 LU plot, in favour to Unpalatable and Thorny ones, and the percentage increase in necrotic biomass (standing hay) are signs of under-grazing, *i.e.* underutilization of pasture, which leads to habitat degradation since the regrowth and propagation of Palatable species is impaired. The low stocking rate, due to lower tread, lower total ingestion by the flock and the type of selection made by sheep, during two - three years of monitoring has led to a development of unpalatable and thorny species. It is a further confirmation of the importance of animal species at pasture, as well as the habitat of flora and soil. In homologous conditions, the use of mowing and cleaning up, made in accordance with the phenological stages and physiological phases of wildlife, is considered absolutely necessary. In case of 4 LU stocking rate, similar in the two case studies, the result was an expression of effectiveness of the limit, in fact the habitat did not show signs of plant pauperisation. The results from 6 LU plot confirmed the vast bibliography on the damage of overgrazing: the percentage increasing of bare soil surface at the end of grazing season is a sign of deterioration of the habitat vegetation, and common effect of the over-grazing condition. The high stocking rate, in fact, caused the loss of ground cover for the increased poaching of soil, but especially for the high demand for herbage intake. The land cover degradation was also aggravated by thistles and asphodels, characteristic species of degradation.

Biomass production

Dry matter production of biomass from pasture showed an irregular trend, due to several factors. In ZOE farm, comparing the three plots (Figure 8), we can observe that only in the 0.2 LU plot the biomass never dropped below 20 q/ha, while in 6 LU plot the biomass practically fell to zero in August 2013. In the third year of monitoring (2014) DM production in 0.2 LU plot was higher, but mainly due to dry grass remained from the previous year, and pulled down by snowfall. This mass has a negative effect on the regrowth of Palatable species, such as Legumes and Others, competing for space and light. Over the two years of monitoring in AAM farm the production of dry matter halved in the plot overgrazed (6 LU) in the second year (from about 6 to less than 3 tons/ha), due to the excessive use of pasture in the previous year that did not allow the vegetation to produce enough seed to regenerate the sward in the following year. Both 4 and 0.2 LU plot, on the contrary, did not affect the variation of production in the two years of monitoring, showing only an insignificant decrease in the production from the first to the second year (Figure 9).

Biomass quality

The results (samples taken in ZOE farm) (Figure 10) showed a not significant decrease in crude protein content in the plot 4 LU, while an irregular trend in the 6 LU. While the crude fibre content appeared to

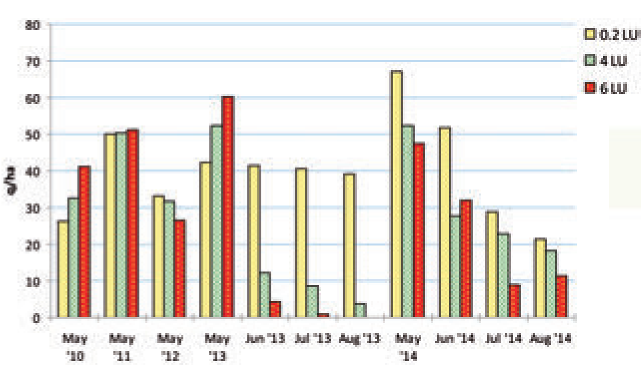

Figure 8. Herbage yield (q DM/ha) in ZOE farm.

be closely linked to the climate, more explicative was the variation in lignin content, almost constant in the 4 LU plot and significantly increased in the other two parcels, respectively signs of under- and over-grazing.

Animal monitoring

In ZOE farm the changes in weight, physiological, have followed an upward trend until July, when shearing, contrarily to AAM farm, where the first year of monitoring the group of sheep from 0.2 LU showed almost constant weight, while in the second year there was a slight increase (about 2 kg/head). In this same farm, animals grazing in F2 plot (4 LU) showed an increase in weight in both years of monitoring (2.8 and 3.9 kg/head, respectively). In the CF plot (6 LU) the animals suffered a steady decrease in weight in the first year, up to more than 4 kg/head, while in the second year the weight of the animals unchanged. The BCS showed a similar pattern in the F1 groups in both case studies, with a downward trend at the end of grazing season (0.25 points) and not significant changes in F2 group. CF group showed constant values in the first year (2.75 to 2.85), and a slight decrease in the last year in ZOE farm (0.25 points) but a slight increase (0.25 points) in AAM farm.

Competitiveness gap

Negative values in Table 2 indicate an economic advantage in case of compliance with the standard, while positive values indicate an economic loss determined by the increased costs. The data reported in the Table 2, whose trend has been represented in Figure 11, show that reducing the stocking rate from 6 to 4 LU/ha/year the values always become negative, due to the variation of the pasture rent costs and to the three types of the pasture quality. In fact, with 4 LU stocking rate, the trend of the lines representing the three pasture types, showed extremely limited variations both for the increase in the pasture quality and its rent costs, with ranges from -13.02 € year^{-1} head^{-1} (poor pasture and zero rent) to -6.80 € year^{-1} head^{-1} (rich pasture and 150 €/ha/year as rent). The compliance with the standard has determined always a low economic advantage. On the contrary, reducing the stocking rate from 6 to 0.2 LU, a wider variation of the economic competitiveness gap occurred, from negative to positive values. In this case the influence of the rent variation and the pasture quality were more pronounced than in the previous cases. The convenience to the compliance with the Standard, in reference to the parameters used in this simulation, occurred for rent values below 80, 110 and 120 € year^{-1} head^{-1} for rich, middle and poor pasture respectively. Therefore, based on these assumptions, when the rent costs exceeded these values there was a loss of economic competitiveness, whose quantification is shown in Table 2 (loss of economic competitiveness up to 51 € year^{-1} head^{-1} for the high quality meadow, up to 32 € year^{-1} head^{-1} for medium quality and up to 22 € year^{-1} head^{-1} for the low quality meadow).

Conclusions

The monitoring has shown contrasting results for effectiveness of the Standard 4.6 as far as floristic and phytosociological analysis on one side and the parameters of the organic carbon and soil biological fertility on the other side. These results have suggested excluding the organic carbon as a principal indicator for the evaluation of habitat preservation of a permanent pasture. The minimum limit of stocking rate 0.2 LU/ha was not effective in both the monitoring case-studies, which showed common signs of under-grazing. The maximum limit 4 LU/ha has instead proved effective with regard to most of the parameters analysed (flora, soil microbial activity and economics). However

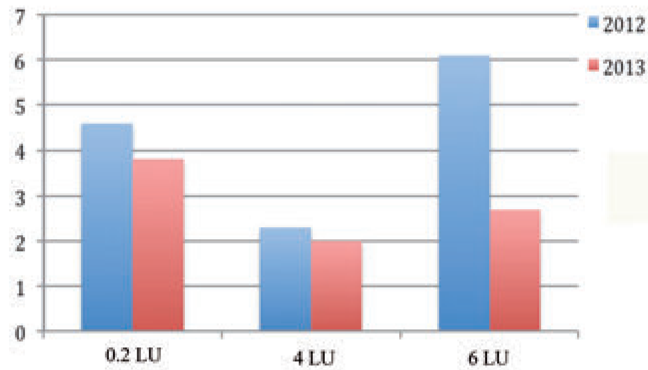

Figure 9. Herbage yield (t DM/ha) in AAM farm.

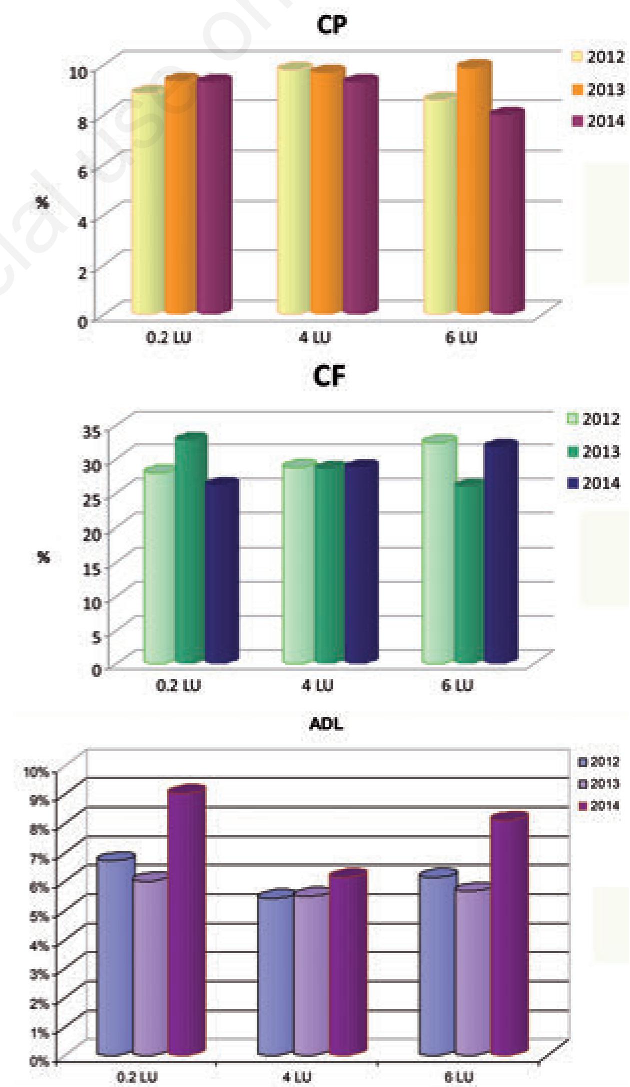

Figure 10. Crude protein, crude fibre and lignin (Acid Deterged Lignin) content in herbage during monitoring study in ZOE farm.

the authors wish to emphasize that the cases monitored were two Italian farms, not generalizable at national level, both for differences in habitat (mountains hill, lowland) and climate, grazing system, since they have monitored the effectiveness in a sheep continuous grazing system. Further studies are needed, on the one hand to evaluate the efficacy in mixed systems (grazing cows, sheep, goats) and, secondly, to identify main areas that are considered homogeneous for biomass available during the year, the flora biodiversity and the grazing system.

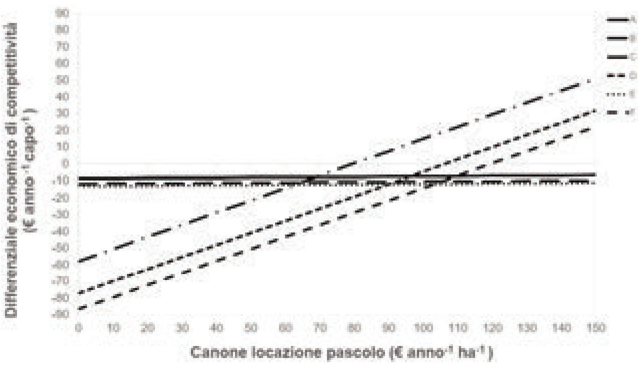

Figure 11. Trend of the values of the economic competitiveness gap for the two limits of the Standard relating to the cost per year per head (€ year^{-1} head^{-1}) as a function of the rent and the three levels of pasture quality.

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Table 2. Values of the economic competitiveness gap for the two limits of the Standard relating to the cost per head (€ year^{-1} head^{-1}) as a function of the rent and the three levels of pasture's quality.

Rent for pasture (€ ha^{-1} year^{-1})	(A) From 6 to 4 LU ha^{-1} year^{-1} rich quality pasture	(B) da 6 a 0,2 LU ha^{-1} year^{-1} poor quality pasture	(C) From 6 to 4 LU ha^{-1} year^{-1} medium quality pasture	(D) From 6 to 0.2 LU ha^{-1} year^{-1} medium quality pasture	(E) From 6 to 4 LU ha^{-1} year^{-1} poor quality pasture	(F) From 6 to 0.2 LU ha^{-1} year^{-1} poor quality pasture
0	-8.68	-57.82	-11.57	-77.09	-13.02	-86.73
10	-8.55	-50.57	-11.45	-69.84	-12.90	-79.48
20	-8.43	-43.32	-11.32	-62.59	-12.77	-72.23
30	-8.30	-36.07	-11.20	-55.34	-12.65	-64.98
40	-8.18	-28.82	-11.07	-48.09	-12.52	-57.73
50	-8.05	-21.57	-10.95	-40.84	-12.40	-50.48
60	-7.93	-14.32	-10.82	-33.59	-12.27	-43.23
70	-7.80	-7.07	-10.70	-26.34	-12.15	-35.98
80	-7.68	0.18	-10.57	-19.09	-12.02	-28.73
90	-7.55	7.43	-10.45	-11.84	-11.90	-21.48
100	-7.43	14.68	-10.32	-4.59	-11.77	-14.23
110	-7.30	21.93	-10.20	2.66	-11.65	-6.98
120	-7.18	29.18	-10.07	9.91	-11.52	0.27
130	-7.05	36.43	-9.95	17.16	-11.40	7.52
140	-6.93	43.68	-9.82	24.41	-11.27	14.77
150	-6.80	50.93	-9.70	31.66	-11.15	22.02

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