Costs of forage production in disadvantaged mountain areas

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Abstract

Mountain grassland represents an important source of ecosystem services. Its conservation is best achieved by means of a site-specific agricultural use, but less-favoured areas are currently endangered by abandonment because of ongoing socio-economic changes. In order to get a reliable figure of the costs of forage production for the mountain meadows of South Tyrol, an assessment including machinery and personnel costs, as well as the respective working times, was conducted in 2011 for 100 plots on 19 grassland farms. Our results show a greater labour input as the steepness of meadows increases and the dimension of plots declines. Thus, as far as farmers are rational economic agents, specific compensation measures are required for the conservation of extensive grasslands.

Keywords: forage production costs, labour input, natural constraints, ecosystem services

Introduction

Mountain grassland, and extensive grassland in particular, represents an important source of ecosystem services, such as biodiversity, landscape diversity and protection from soil erosion. The conservation of this valuable grassland is best achieved by means of a site-specific agricultural use. There is evidence that in mountain regions of the Alps, extensive grassland is likely to be found in areas characterized by unfavourable climate and topography (Niedrist *et al.*, 2009), which in turn represent a limit to intensification and mechanization. However, such areas are currently endangered by abandonment. This paper focuses on the effects of natural constraints on the costs of forage production in the mountain region of South Tyrol (Italy).

Materials and methods

In order to get a reliable figure for the costs of forage production depending on natural constraints, a survey was conducted in 2011 on 19 farms of the Puster valley. Data were collected in 100 selected grassland fields, encompassing a wide range of altitude, slope conditions and field size (Table 1). These fields are almost exclusively fertilized with the farm's own manure at a loading derived from a mean stocking rate of 1.8 livestock units ha^{-1}. About one-fourth of the investigated area is used for silage. Gross DM yields of between 5.9 and 9.4 Mg ha^{-1} can be expected in this region depending on altitude and management intensity (Kasal *et al.*, 2004). Field area, median of slope and mean altitude of the investigated fields were calculated with the Zonal Statistics as Table-tool and Zonal Histogram-tool of ArcGis 10.0 at a raster resolution of 20 m. Under the supervision of technical personnel, the farmers recorded over the whole year the labour time, the machines and devices used, the personnel involved and all other occurring costs for each operation. Apart from some tasks performed by contractors, the field work is mostly done by farmers and other unpaid family members and/or neighbours. Its economic cost was estimated according to an opportunity cost approach. Among the available methodological alternatives (AAEA, 2000), reference was

made to the wages of the collective agreement for agriculture: the unpaid labour of farmers and other operators with an agricultural training was evaluated at the rate of skilled workers, and that of people without an agricultural training at the rate of semi-skilled workers. Labour of children younger than 16 and of elderly people more than 65 years old was also taken into account, although at a minimum wage. The costs of machinery were computed according to Gazzarin (2011), taking amortization costs, repair costs, as well as the fuel costs for towing vehicles into account. Farmers provided information on the purchase price of the machinery and its service life. The yearly working hours of the machines were computed as the sum of the time records of the working steps, further corrected according to estimates of the farmers concerning the use of machinery in other fields not assessed in this project. Given the local context, no opportunity cost of land was considered. The data presented in this paper do not take travelling and transport times into account, in order to make the results independent from the fields' distance to the farm buildings.

Table 1. Summary of site factors and size of the investigated fields (n = 100).

	Minimum	Maximum	Mean ± SD
Altitude (m a.s.l.)	807	2084	1277 ± 290
Slope (°)	2.0	41.2	18.5 ± 10.1
Field area (ha)	0.11	8.26	1.88 ± 1.62

Data were processed by means of a Principal Component Analysis (PCA) using transformed z-scores of altitude, slope and field area. The relationships of the unitary costs and labour input with slope, field area and altitude were described using the Curve Estimation procedure of PASW 17.0.2.
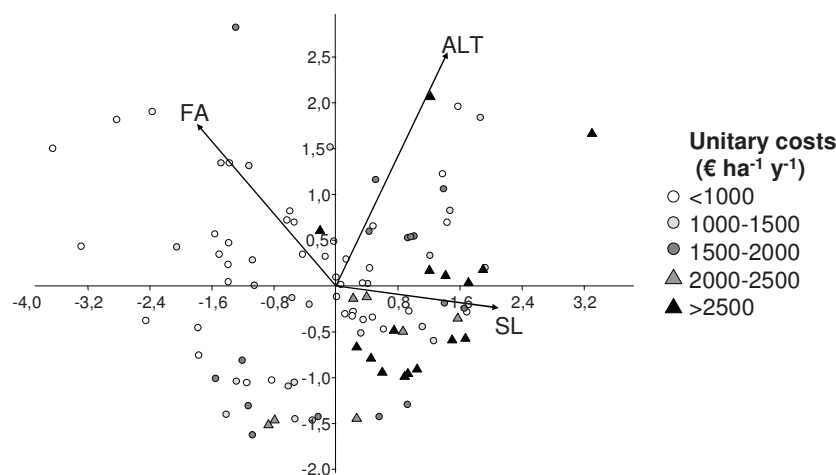

Figure 1. Ordination diagram showing the results of PCA on site factors and plot size (SL = slope, ALT = altitude, FA = field area).

Results and discussion

The first two PCA axes accounted for 83.9% of the total variance (54.2% for the first axis and 29.7% for the second one). Along the first component a rough separation of the two lowest and the two highest cost classes, positively related to slope and to a smaller extent to altitude, was apparent (Figure 1). A negative relation with the field area was also observed. This is consistent with the fact that increasing mechanization constraints occur with increasing slope.

Altitude would be likely to become more relevant if costs per forage yield unit instead of area unit were considered, as climatic constraints are expected to reduce the forage production with increasing altitude. Less expected was the relatively large effect of the field size on the total costs, which may be explained by two different issues: by the needs for machine turning and the larger proportion of field margins in small fields on the one hand, and by the over-proportionally increasing effect of rounding the working times with decreasing field size on the other hand. The incomplete separation of the cost classes suggests that factors other than topography and climate (here roughly described by the altitude) play an important role in determining the production costs, such as the management strategies of the individual farmers, concerning for instance the propensity to renew their machineries.

According to the results of the PCA, unitary costs and labour input were found to increase with increasing slope and with decreasing field area. The regression analysis showed that these relationships are best described by non-linear, highly significant functions, explaining however, the total variance only to a partial extent (Table 2). No significant relation with altitude was found.

Table 2. Effect of slope and field area on production costs and labour input (*** denotes $P < 0.001$).

Dependent variable	Independent variable	R^2	Function
Production costs ($€ \ ha^{-1} \ yr^{-1}$)	Slope (°)	0.27***	$y = 1.750 \ x^2 - 15.717 \ x + 1085.166$
	Field area (ha)	0.26***	$y = 1473.148 \ x^{-0.353}$
Labour input ($h \ ha^{-1} \ yr^{-1}$)	Slope (°)	0.37***	$y = 17.53 \ e^{0.0451x}$
	Field area (ha)	0.29***	$y = 46.651 \ x^{-0.511}$

Conclusions

The present paper provides evidence for increasing production costs and labour input as field steepness increases and the field size decreases. These fields in particular are most likely to be managed extensively and in turn to provide non-marketable, environmental and social ecosystem services. As farmers are rational economic agents, public payments for these services are therefore crucial for ensuring them in the long term.

Acknowledgements

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