



Livestock systems and environment on the Alps

E. Sturaro

Department of Animal Science, University of Padova, 35020 Legnaro (PD), Agripolis – viale dell'Università 16., Italy

ABSTRACT

Extensive livestock systems in mountain areas have a relevant ecological role. Traditional farms, based on use of local forages and pastures contribute to maintain environmental quality and biodiversity of mountain ecosystems. Mountain agriculture experienced a dramatic decline in the last years, a phenomenon mostly driven by socio-economic factors such as immigration into lowland where new economic opportunities are offered to rural people. The abandoning of traditional extensive farming has been associated with land use changes and loss of biodiversity. This paper analyse the evolution of livestock farms in the Alps, focusing on environmental sustainability of production systems.

(Keywords: livestock systems, mountain, environment)

INTRODUCTION

In recent decades European agriculture has experienced radical changes, with a decrease in farm numbers and the abandoning of traditional extensive farming in favour of highly mechanised and intensive production practices (Caraveli, 2000; Höchtl *et al.*, 2005; Strijker, 2005). This process has been particularly dramatic for the traditional extensive livestock farms of the Alpine region (Caraveli, 2000; MacDonald *et al.*, 2000; Bonsembiante and Cozzi, 2005; Lasanta *et al.*, 2006).

It is generally accepted that extensive farming practices increase environmental quality and biodiversity of agro-ecosystems as compared to intensive ones (Hoogeveen *et al.*, 2002). More specifically, the abandoning of traditional farming in mountain areas has been associated with extensive reforestation (Garcia-Ruiz *et al.*, 1996; Bebi and Baur, 2002; Gellrich *et al.*, 2007), soil degradation, loss of biodiversity (Conti and Fagarazzi, 2005), and a decrease in landscape quality and attractiveness (Giupponi *et al.*, 2006).

The aim of this paper is to analyze the evolution of livestock systems in mountain regions, taking the Alps as study area, and to investigate the relationships between animal husbandry and environmental features.

Livestock systems in European mountain areas

Animal husbandry is largely diversify across European mountain areas. Geographic and climatic traits represent limits for feedstuff production, traditionally based on forages and pasture. For centuries, cattle and small ruminants able to optimize these kind of resources were reared in extensive or semi-extensive systems (Cozzi and Bizzotto, 2004). A schematic classification of livestock systems is showed on *Table 1*. On the Alps, cattle husbandry is historically based on small herds of local dual purpose breeds for milk and meat production, housed in closed barns located in the valley during winter and moved to alpine summer pastures from June to September. Local dual purpose breeds well

adapted to mountain environment were widespread in the alpine regions, such as Simmenthal, Brown Swiss, Grey Alpine, Valdostana and Rendena in Italy, Abondance and Tarentaise in French and Herens in Switzerland.

Table 1

Classification of livestock systems on Alps

Livestock system	Management	Feeding	Reproduction	Products
Dairy cattle (or goat) without summer pastures	Free or tie stalls (free for goats)	Forages and on farm pastures	All year long	Milk and calves
Dairy cattle (or goats) with summer pastures	- Winter: Free or tie stalls - Summer: moved to alpine pastures	- Winter: forages and concentrates supplementation - Summer: pastures and concentrates supplementation	Seasonal or all year long	- Winter: Milk and calves (or kids) - Summer: milk or cheeses
Transhumance : sheep	- Winter: lowland, stalls; - Spring-summer: alpine pastures	Pastures with few supplementary feeding	Seasonal	Lambs (in some cases cheeses and wool)
Suckling cows	- Winter: stalls - Spring-summer: pastures	Forages and pastures	Seasonal	Calves

Modify from *Bovolenta et al. (2008)*.

Milk were traditionally processed on-farm or in small cooperative cheese factories, and a large variety of high quality cheeses are still strictly connected with mountain dairy systems. Small ruminants are also reared to produce meat, milk and wool. Sheep and goats are able to use the less favourable pastures, where dairy cows are excluded. Traditionally small ruminants are reared in large flocks with low grazing pressure. An example of sustainable productive livestock farming is represented by dairy small ruminants for production of local cheese still present in some regions of Alps (e.g. Piemonte in Western Italian Alps, *Battaglini, 2007*). The most outstanding feature of sheep farming systems in some alpine regions is the vitality of the traditional transhumance based on the integrated use of alpine pastures and of hill and plain marginal foraging resources. This system was able to adapt to the changes in land uses and food consumption, and is still used in some area. An example is the husbandry of Bergamasca/ Biellese sheep in Lombardia for the production of heavy lamb (*Corti, 2007*).

These kind of extensive systems contribute to create and maintain the typical alpine ecosystems, with forest fragmented by open areas such as meadows and pastures (*Giupponi et al., 2006*).

Evolution of Livestock systems in the Alps

In the last decades, the Alps experimented a general abandonment of traditional farms, with different regional trends. According to *Streifeneder et al. (2005)*, the number of farms in the period between 1980 and 2000 decreased of 40% (*Table 2*). The highest percentage of ceased farms occurred in the most decentralised areas of the European Alps, where farm holdings, generally small and unprofitable, were abandoned (*Giupponi*

et al., 2006; *Tasser et al.*, 2007). In the same context, in regions that are to some extent disadvantaged in relation to the natural-site conditions, such as *Südtiroler Berggebiet* and *Innsbruck Land* in Austria, as much as 37% of land has been dismissed. Similarly, in Carnia region, Italy, nearly 67% of the formerly agriculturally used areas have been abandoned too (*Tasser et al.*, 2007). In Austria and Germany changes were rather modest, whereas they were very strong in Italy, France and Slovenia. In particular the smallest farms ceased, with a tendency to increase the number of animals per farm. This process have led to choose more specialized breeds, such as Holstein Friesians or Brown-Swiss whose are common on the more intensive farms; small regional dual purpose breeds are maintained only in the small traditional herds.

Considering the use of permanent grassland, at the alpine border regions, in Germany, Slovenia and eastern Austria, husbandry is characterised by an high intensity (*Table 2*). On the opposite there are extremely extensive used regions in France and Italy. In general, livestock density does not increase due to additional livestock but due to decreasing areas of permanent grassland (*Streifeneder et al.*, 2005). In many alpine summer pastures stocking rates are managed at sub-optimal levels and therefore are only partially constrained by pasture productivity (*Mrad et al.*, 2009).

The evolution of animal husbandry shows different trend at regional level. In the same country is possible to have marginal areas with farm abandonment and other zones characterized by maintenance of sustainable livestock systems. An example of this situation is given by Eastern Italian Alps. The total surface covered by the three bordering provinces of Bolzano, Trento and Belluno is about 17,000 km², and is classify as completely mountain area. In *table 3* the changes of livestock indicators between 1980 and 2000 are reported (data from official censuses *ISTAT*, 1982 and 2002).

The province of Bolzano experimented a mild loss of dairy farms, with an increase of dairy cows and as a consequence an increase of herd size. The distinctive trait of Bolzano dairy sector is the maintenance of a large number of small familiar farms. The increase of small ruminants was higher, in particular the number of goats in 2000 was doubled with respect the 1980. The maintenance of sustainable farms have permitted to maintain grassland and pastures surface. The situation is different in Trento and Belluno. Both the provinces experienced a dramatic abandonment of small dairy farms, with a percentage of ceased farms of about 80% in only 20 years. In 2000 there were less farms with a higher herd size (11.2 cows/farm in Belluno and 16.8 in Trento, almost the double with respect to Bolzano). For sheep and goats a large percentage of farms closed, with a consequent increasing of herd size in the active ones.

The most evident consequence on landscape is the loss of open areas, which was moderate in Trento but relevant in Belluno (-8 and -25%, respectively). The abandonment of extensive farms based on marginal grassland caused a progressive encroachment of meadows and pastures, followed by reforestation. Also in the territory of these two provinces there are different situation. In the north of Belluno the farm abandonment and the consequent loss of open areas is strongest than in the south; in fact the north is characterized by higher elevation and in the south are concentrated the most economically viable farms and there is also the only industrial cheese factory of the province (*Giupponi et al.*, 2006).

In the Bolzano province there is a particular institution, the Tyrolean Closed Farm (*Geschlossener Hof*), which is a indivisible agricultural holding that has been passed down from father to first-born son for centuries. The maintenance of this tradition in an Autonomous Province totally mountainous with a strong touristic attractiveness permitted to avoid the livestock abandonment experimented by the other bordering areas.

Trento is also an Autonomous Province, and the policies aimed to sustain the agriculture and to promote the development of multifunctional farms helped to maintain a sustainable sector. At the opposite, Belluno is part of the Veneto region, where the main urban settlements and economic activities are located in the lowland. This different trends in similar environmental conditions should be explained by a range of factor, and this phenomenon should give relevant consequences on land-use changes. These aspects will be discussed in the next paragraphs.

Table 2

Variation of farms and livestock units between 1980 and 2000

Country	Agricultural farms, number			Livestock units (LU), total			LU/permanent grassland, ha		
	2000	1980	2000-1980 (%)	2000	1980	2000-1980 (%)	2000	1980	2000-1980 (%)
Austria	96,205	119,837	-19.7	1,076,656	1,210,981	-11.1	0.7	0.8	-8.3
Switzerland	26,562	41,363	-35.8	538,066	607,310	-11.4	2.0	2.2	-8.6
Germany	22,511	31,623	-28.8	661,064	705,028	-6.2	2.1	1.7	24.2
France	28,571	52,647	-45.7	384,604	563,752	-31.8	0.7	1.1	-34.6
Liechtenstein	199	494	-59.7	4,608	6,524	-29.4	1.8	2.2	-18.5
Italy	171,038	309,146	-44.7	642,546	900,283	-28.6	0.6	0.7	-14.9
Slovenia	23,149	53,089	-56.4	146,399	181,282	-19.2	1.4	1.2	15.2
Alps total	368,235	608,199	-39.5	3,453,943	4,175,160	-17.3	0.9	1.0	-8.9

Modify from *Streifeneder et al.*, 2005.

Table 3

Evolution of livestock systems in Eastern Italian Alps

Variable	Bolzano			Trento			Belluno		
	1980	2000	% variation	1980	2000	% variation	1980	2000	% variation
N of cattle farms	12,792	9,476	-26	6,435	1,678	-74	4,763	1,137	-76
N of cattle	139,708	144,196	3	61,446	45,050	-27	35,830	20,606	-42
N of dairy farms	12,317	8,565	-30	5,749	1,416	-75	4,317	807	-81
N of dairy cows	63,132	75,468	20	28,770	23,812	-17	16,097	9,043	-44
Dairy cows/farm	5,1	8,8	76	5,0	16,8	236	3,7	11,2	203
N of sheep farms	2,080	2,136	3	418	320	-23	740	342	-54
N of sheep	25,796	39,739	54	13,977	20,377	46	5,259	5,615	7
N of goat farms	1,397	1,725	23	820	429	-48	855	244	-71
N of goat	7,930	15,714	98	2,923	5,132	76	2,262	2,318	2
Grassland and pastures (ha)	230,163	240,153	4	120,316	110,196	-8	63,349	47,446	-25
Crops (ha)	7,542	3,780	-50	6,583	1,982	-70	4,892	5,232	7

Drivers of changes in alpine livestock systems

The rapid changes of European agriculture were determined by various factors, in particular socio-economic development and innovation in farm technology. At the same time, significant changes in land use were observed with large implications for the sustainability of grazing agro-ecosystems (*MacDonald et al.*, 2000). In the Alps, increasing economic pressure to maintain farm incomes has resulted in intensification of the more accessible (and productive) soils and in a partial abandonment and fragmentation of semi-natural habitats, characterized by soils with a low nutrient status

and farms with high labour requirements. The main cause of farm abandonment across the entire alpine region is the retirement of farm managers (*MacDonald et al.*, 2000). Potential successors and heirs are not interested in taking over the operation of a farm since the income thus generated is less than satisfactory and employment opportunities are more attractive in other sectors. Since potential successors move to regions with better employment opportunities, as already mentioned, regions with high migration rates often entail a decrease in the agricultural sector. In the eastern Italian Alps is this the case of the Belluno province, where in last decades the development of small industries (in particular for glasses production) and services connected to the tourism led to farms decline (*Giupponi et al.*, 2006). Regions with a sound regional-economic environment and, therefore, a relatively stable population trend on the other hand register lower rates of farm abandonment.

In terms of the general socio-economic context that surrounds ruminant livestock farming in Europe, the Common Agricultural Policy (CAP) plays a central role, resulting in a polarization of production areas and a loss of mixed farming. Although it has prevented some low-intensity systems with high biodiversity from being abandoned, it has also lead many marginally economic areas to be forsaken (*MacDonald et al.*, 2000). The successive reforms of the CAP tried then to recognize the important role of farms in the sustainable management of territories: agri-environmental measures in 1992, rural development policy and farm territorial contracts in 1999, and payment based on environmental criteria including the reform of the CAP in 2003 (*Gibon*, 2005). CAP 1992 (expanded by the Agenda 2000) implemented compensation payments and extensification policies that have caused enlargement of herd sizes and great dependency on subsidies (*Veysset et al.*, 2005); production objectives declined and, to a large extent, farmers' gains were based on maximising the capture of premiums. The mid-term review of the CAP implied decoupling of subsidies from production and a progressive regression of economic support, which might result in changes in the observed trends as a consequence of new adaptation strategies of farmers. Furthermore at farm level the internal structure and economy influence the evolution of mountain agriculture. One fundamental aspect that explains the permanent disappearance of farming and subsequent abandonment of large pastoral areas in the Alps is the lack of continuity of agricultural households, directly related to the presence and number of descendants, but other aspects are also involved. One of the most relevant ones is the high opportunity cost of household labour, especially for the younger family members. These general factors, associated with other local specific situation, contributed to abandonment of mountain farming, which was for centuries the main occupation for people living on Alps.

Effects of changes in alpine livestock systems

Environmental impact is one of the emerging problem of livestock sector. In mountain areas the environmental issues related to evolution of livestock systems are land use changes and loss of biodiversity, as reported by many authors (*Table 4*). In a general review on agricultural abandonment in mountain areas, *MacDonald et al.* (2000) showed that the reduction of traditional farming practices (such as transhumance or hay meadow management), or land abandonment cause loss of biodiversity, loss of open pastures, reforestation, and also a loss of characteristic decentralised farm settlements. In fact, in mountain areas already dominated by high forest cover, increased woodlands caused by abandonment processes may not be desirable, leading to a biodiversity loss due to a diminished variety of habitats: when small patches of open meadows, woodlands and

cultivated fields shape landscape, then forest expansion might result in an increased landscape homogeneity and banalisation (*Conti and Fagazzari, 2005*).

In the Swiss Alps, *Gerlich et al. (2007)* evidenced that intensification is not convenient, because farm labour costs increased faster than incomes, leading to under-grazing and the cessation of tree and shrub clearance.

In the eastern Italian Alps, different studies demonstrated that the decline of traditional extensive livestock systems caused a loss of open areas, with a process of reforestation, simplification of the landscape and loss of biodiversity (*Giupponi et al., 2006; Marini et al., 2009*). At the regional scale, the substitution of small farms with large and intensive farms is causing eutrophication of flat areas and abandonment of steep extensively-managed areas, with negative consequences on plant and insect diversity. Traditional animal husbandry should be maintained, as grassland management related to these systems demonstrated to support greater biodiversity than modern and intensive systems.

Local government are trying to address policy decision to sustain the multifunctional role of traditional extensive systems on the Alps. For example, since the '90 the Swiss government grants mountain farmers financial compensation for lower agricultural yields in exchange for landscape management and ecological services: ecological compensation area (ECA). The co-existence of well-managed pastures and long-term ecological compensation area (meadows) might best conserve mountain grassland biodiversity (*Kampmann et al., 2008*).

Table 4

Effects of livestock abandonment on land use change and biodiversity

Authors	Study area	Change in livestock systems	Effects on land use and biodiversity
<i>McDonald et al., 2000</i>	Different study areas in Eastern and Western Alps, from France to Slovenia	Dairy farming in Eastern and Western Alps, Sheep in Eastern Alps (Tyrol and Triglav): Intensification in conjunction with abandoning	Negative
<i>Giupponi et al., 2006</i>	Belluno, Eastern Italian Alps	Decreasing of farms/km ² UAA and increasing of cattle/farm. Less farms concentrated in the most favourable valleys with larger herd size.	Negative
<i>Gellich et al., 2007</i>	Swiss Alps	cultivation, cattle, sheep and goats. 1965-1990 farms number decreased (33%), average farm size increased.	Negative
<i>Kampmann et al., 2008</i>	Eastern Central & Northern Alps of Switzerland	Grants for ecological services	Positive
<i>Marini et al., 2009</i>	Trento, Eastern Italian Alps	1990-2000: number of farms decreased by 50%, the mean number of LU per farm increased from 16 to 26.	Negative

In general, agricultural and livestock activities in mountain areas must be evaluated not only for their economic viability, but also for: limitation of soil erosion, diversification of sources of income in agricultural farms, increasing of motivation and satisfaction for the farmer. Animal husbandry is also important for the tourism, because for many people the mountain natural environment is strictly related to livestock presence. Traditional practices survive in some areas only because of the requirements associated with the production of specialist cheeses (and the associated higher price of the milk), but in many areas EU hygiene and health standards for producing and marketing milk and dairy products, and the structural requirements for dairies, are causing problems for both producers and the competent authorities. There is a risk that these enterprises will be regarded as illegal leading to further abandonment of mountain pastures with associated loss of biodiversity and the increase in shrub/forest.

Also local policies must be addressed to pay for the environmental services of traditional livestock systems, which is fundamental for the maintenance of ecosystems and mountain culture, both seriously endangered during the last decades. Regional policies based on subsidies risks to be no longer sustainable, and future new strategies aimed to pay for product quality and environmental services of mountain farms must be developed to support the extensive livestock systems on the Alps.

CONCLUSIONS

The evolution of livestock systems on the Alps shows that the abandoning of traditional practices cause a loss of natural resources in mountain areas. Traditional extensive systems did not guarantee economic viability; on the other hand, intensification is a losing strategy in mountain area, because the higher costs for feeding and services with respect the lowland and the impossibility to reach the same productive results. The sustainability of traditional, extensive farming should be promoted only through a “multifunctional farming” approach. The lower productivity of extensive production practices should be compensated by increasing the farm revenues through direct processing and marketing of products (on farm or in cooperation with other farmers), such as DOP cheeses. In the most favourable areas, also agro-tourism activities should be an opportunity to diversify the incomes; but in this case the risk is to lose the original agricultural vocation, with negative effect on grassland maintenance.

Finally, local policies must sustain traditional extensive systems paying for the landscape conservation and use of environmentally friendly practices. System dynamic studies become essential, not only to understand the changes that occurred in the past and identify what were the main drivers but also to forecast the changes that might happen in the future. If we can anticipate the evolution of farming systems, we might as well be able to support the design of more effective policies.

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Corresponding author:

Enrico Sturaro

Department of Animal Science, University of Padova
I-35020 Legnaro (PD), Agripolis – viale dell'Università 16., Italy
Tel.: +390 49 8272641; fax. +390 49 8272669
e-mail: enrico.sturaro@unipd.it