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LIVESTOCK SYSTEMS AND FARMING STYLES: GRASSLAND MANAGEMENT, LANDSCAPE AND BIODIVERSITY, VENETO REGION, NE ITALY

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« Science is a process of ruling out ideas that are not true,
always leaving some uncertainty about the ideas we think are true. »

Eric J. Gustafson

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ABSTRACT

Traditional farming systems have been abandoned to the favour of intensified agricultural practices, due to environmental, structural, economic, and socio-political constraints. Consequently, mountain landscape and biodiversity were seriously affected. The aims of this PhD thesis were to study the widespread of the abandonment phenomenon, in particular in the Alpine area, in order to understand its driving forces. The first chapter was about farming abandonment in the mountain and marginal European areas, the main factors that leads to such event, the major consequences and possible solutions, focusing in particular on landscape and biodiversity issues. The second contribution was dealing with structural and productive features of the traditional farming sector in the Belluno province, where we have identified the main livestock production systems as well as the major farming styles. Our focus was mainly on landscape and open areas maintenance. The third chapter was set up in order to identify and study the main management systems of the summer pastures in the Veneto region as well as their economic convenience/inconvenience. Finally, the fourth contribution was about the different farming styles existing within the summer pastures of the Veneto region. Data were gathered by means of on-farm questionnaires, regarding technical, productive and non productive features. For statistical analysis, we used a multivariate approach through a non-hierarchical *K-means* clustering technique, to classify both farming systems and styles. A X^2 was used to compare between farming systems within the study areas. In the Belluno province, 65 farms were considered for the study, and we were able to cluster the livestock production system into 6 different groups: 1- *Intensive beef cattle*; 2- *Extensive beef cattle*; 3- *Large sheep and goats*; 4- *Small sheep and goats*; 5- *Intensive dairy cattle*; 6- *Extensive dairy cattle*. Intensive systems were production-oriented, with large herds and modern structures, machineries and equipment, whereas the traditional ones were managed in a marginalised way due to obsolete and inadequate structures and equipment, but diversifying their production through on farm cheese making and mixed farming. These latter have proven to maintain more the pastures and meadows respect to the intensive systems, especially when the topographical conditions become harsh and hard. In the Alpine and sub-alpine part of the Veneto region, however, on the basis of 485 summer pasture units, we identified 7 different management systems: 1- *Milk production*; 2- *Cheese production*; 3- *Agritourisms*; 4- *Disadvantaged*; 5- *Dry and replacement cows*; 6- *Dry cows and Small ruminants*; 7- *Long summering*. The productive systems (Clusters 1, 2 and 3) were mainly targeting production, processing, and product retail, however, the non productive ones (Clusters 4, 5, 6, and 7), were mainly holding dry and replacement animals and were not interested in production or transformation. These different systems proved to concentrate spatially in different portions of the territory, showing the linkage between farming system and territory. Regarding the farming styles, in the Belluno province, we identified 4 different ways of farming: 1- *Forced farmer*; 2- *Innovative/Organic farmer*; 3- *Innovative*; 4- *Traditionalist*. Farming styles were distributed across all livestock systems, indicating the lack of a linkage between the assignment of a farm to a livestock system and the way the farm is managed. In the Alpine area of the Veneto region, however, we identified other 4 different farming styles: 1- *Young traditionalist*; 2- *Mature traditionalist*; 3- *Young businessman*; 4- *Mature businessman*. Businessmen were those prevailing the diversification of their production to increase the farm income, however, traditionalists were those maintaining a traditional farming with low economic motivation and toward product transformation and retail.

In general, we found that the variability of livestock production systems in mountain areas is high, they differ not only in production practices but also in the ability to maintain landscape. Moreover, within a given livestock system, farms might be managed with different styles, which implies that public support as well as policy decisions should take into consideration these features and integrate the definition of livestock systems with the assessment of farming styles in order to better define the aid strategies of the entire mountain farming sector.

Keywords: Livestock production systems, Farming styles, summer pastures, Alps.

RIASSUNTO

I sistemi agricoli tradizionali sono stati abbandonati a favore di pratiche agricole più intensive, per motivi ambientali, strutturali, economici e socio-politici. Di conseguenza, il paesaggio montano e la sua biodiversità sono stati gravemente colpiti. Gli obiettivi di questa tesi di dottorato sono stati di studiare la diffusione del fenomeno di abbandono, in particolare nella zona alpina, al fine di comprenderne le cause. Il primo capitolo era relativo all'abbandono dell'agricoltura e in particolare della zootecnia nelle aree montane e marginali Europee, considerando i principali fattori, conseguenze e possibili soluzioni. Un interesse particolare era dedicato al cambiamento del paesaggio e della biodiversità. Il secondo contributo riguardava gli aspetti strutturali e produttivi della zootecnia tradizionale nella provincia di Belluno, dove abbiamo identificato i principali sistemi produttivi così come gli stili aziendali più importanti. Il nostro interesse era principalmente mirato verso il paesaggio e il mantenimento delle aree aperte. Il terzo capitolo aveva come scopo di identificare i sistemi di gestione delle malghe della regione del Veneto e la loro sostenibilità economica tramite lo sviluppo di un indice economico di vantaggio/svantaggio. In fine, il quarto contributo riguardava i diversi stili di gestione delle malghe del Veneto. I dati sono stati raccolti per mezzo di questionari con visita diretta, riguardando le caratteristiche tecniche, produttive e non produttive delle aziende/malghe. Per l'analisi statistica, abbiamo utilizzato un approccio multivariato attraverso la tecnica di clustering *K-means* non-gerarchico, per classificare sia i sistemi di allevamento che i stili. Un X^2 è stato utilizzato per confrontare tra i sistemi di allevamento all'interno delle aree di studio. Nella provincia di Belluno, 65 aziende sono state considerate per lo studio, e siamo stati in grado di raggruppare i sistemi di allevamento in 6 diversi gruppi: 1- *Bovini da carne intensivo*; 2- *Bovini da carne estensivo*; 3- *Ovicaprini grandi*, 4- *Ovicaprini piccoli*, 5- *Vacche da latte intensivo*, 6- *Vacche da latte estensivo*. I sistemi zootecnici intensivi sono orientati verso la produzione, con mandrie di grandi dimensioni, strutture ed attrezzature moderne, mentre quelli tradizionali sono stati gestiti in modo estensivo a causa di strutture obsolete ed attrezzature inadeguate, ma diversificano la loro produzione attraverso la produzione di formaggio ed allevamenti misti. Questi ultimi hanno dimostrato di mantenere di più i prati e pascoli rispetto ai sistemi intensivi, soprattutto quando le condizioni topografiche

diventano dure e difficili. Nell'area alpina e sub-alpina della regione Veneto, tuttavia, sulla base di 485 malghe, abbiamo individuato 7 diversi sistemi di gestione: 1- *Malghe con produzione di latte*, 2- *Malghe con produzione di formaggio*, 3- *Agriturismi*, 4- *Malghe svantaggiate*; 5- *Malghe di vacche in asciutta o da rimonta*; 6- *Malghe di vacche in asciutta e piccoli ruminanti*, 7- *Malghe di lunga monticazione*. I sistemi produttivi (cluster 1, 2 e 3) mirano la produzione, trasformazione e vendita al dettaglio dei prodotti, tuttavia, quelli non produttivi (cluster 4, 5, 6 e 7), erano principalmente malghe che caricano animali in asciutta e quindi non sono interessate alla produzione o trasformazione. Questi diversi sistemi hanno dimostrato una concentrazione spaziale nelle diverse parti del territorio, mostrando il legame tra sistemi di gestione delle malghe e territorio. Per quanto riguarda gli stili di allevamento, in provincia di Belluno, abbiamo individuato 4 stili diversi: 1- *Agricoltore forzato*; 2- *Agricoltore innovativo/biologico*, 3- *Innovativo*; 4- *Tradizionalista*. Gli stili di allevamento sono stati distribuiti in tutti i sistemi zootecnici, che indica la mancanza di un collegamento tra l'assegnazione di un'azienda appartenendo ad un sistema di allevamento e il modo in cui l'azienda è gestita. Nella zona alpina della regione Veneto, tuttavia, abbiamo individuato altri 4 stili diversi di allevamento: 1- *Tradizionalista giovane*; 2- *Tradizionalista maturo*, 3- *Imprenditore giovane*, 4- *Imprenditore maturo*. Gli imprenditori sono stati quelli che miravano la diversificazione della loro produzione per aumentare il reddito aziendale, tuttavia, i tradizionalisti sono stati quelli che hanno mantenuto i sistemi di allevamento tradizionali e che hanno una bassa motivazione economica e verso la trasformazione e la vendita dei prodotti.

In generale, la variabilità dei sistemi zootecnici di produzione è alta nelle zone di montagna, essi differiscono non solo nelle tecniche di produzione, ma anche nella capacità di mantenere il paesaggio e le aree aperte. Inoltre, all'interno di un determinato sistema di allevamento, le aziende potrebbero essere gestite con stili diversi, il che implica che il sostegno pubblico, nonché le decisioni politiche dovrebbero prendere in considerazione queste caratteristiche e integrare la definizione dei sistemi di gestione con la valutazione degli stili di allevamento, al fine di definire meglio le strategie di sostegno di tutto il settore agricolo montano.

Parole chiave: sistemi di produzione, stili di allevamento, malghe, alpi.

GENERAL INTRODUCTION

In Europe and since the turn of the century, the intensification of cultivation in favourable areas and the abandonment of farming in marginal areas were both driving forces for the agriculture change, landscape and biodiversity modification (*Fjellstad and Dramstad, 1999; MacDonald et al., 2000; Gibon, 2005; Giupponi et al., 2006*). Abandonment of farming and agricultural activities happens due to bio-physical and geographical constraints (*Giupponi et al., 2006; Marini et al., 2008*) as well as political and economic complexities (*MacDonald et al., 2000; Gibon, 2005; Mottet et al., 2007*). Farming marginalisation consequences are multiple, resulting in rural depopulation, landscape changes and sometimes in biodiversity decline (*Baudry, 1991; Baldock et al., 1996; Kobler et al., 2005*). Our interest was focused in particular on the Alps, being an unique environment on the globe, and we wanted to study the traditional alpine farming systems through investigations on alpine pastures and mountain meadows in order to understand the main factors that have led to the abandonment of such areas, looking for practical and sustainable solutions for the future. The mountain farming systems, being sensitive to many natural and institutional constraints, have adopted, in some, the "multifunctional" farming (*Gibon, 2005; Mottet et al., 2007*), in order to come up with farm revenues, through the diversification of farm production, by enhancing the production techniques, and applying some innovative production ways like agritouristic activities, direct processing and marketing of *in loco* products, taking into consideration the importance of maintaining the open areas and landscape aesthetic and attractiveness (*Hunziker, 1995; Giupponi et al., 2006; Sturaro et al., 2009*). However, and even under similar production conditions, farms cannot be managed in the same way (*Van der Ploeg, 1993; Wilson, 1997; Vanclay et al., 2006*). In fact, among farmers could exist a wide heterogeneity, that could be expressed through their motivation and attitudes toward a given production system. *Farming styles*, hence, are used to study the way the farmer behave as regards the management techniques that could adopt for his farming activities, and the decisions that could come up from it. Studying the Alpine farming systems and their management as well as the farming styles of a given area could help us in defining better a sustainable way of use of the Alpine resources (pastures and livestock), in order to enhance the life quality of the alpine rural population and to conserve better the cultural heritage, landscape beauty, and biodiversity.

This thesis will be structured in four main chapters:

The first one is dealing with the abandonment phenomenon that concerns the European marginal areas and in particular the Alps, with a focus on the main factors, consequences, and solutions.

The second chapter will be focusing on a particular area of the Italian North-eastern Alps, the Belluno province, in which we will give an insight about the main farming systems and farming styles that could exist in that area, as well as the importance of the public support to maintain such traditional and vulnerable systems.

The third chapter will be dealing with the summer pastures of the Veneto region and their management systems: the importance of summer pasturing in the conservation of Alpine pasture resources as well as the impact that could have this type of farming in the maintenance of the traditional livestock breeding.

The fourth chapter will be focusing on the summer pasture farming styles in the Veneto region and the role of farmer in taking decisions regarding the pasture management techniques.

Chapter 1

FARMING SYSTEM ISSUES ON LANDSCAPE & BIODIVERSITY CHANGES IN EUROPEAN MOUNTAIN AREAS

Abstract

Throughout Europe there have been two contrasting trends of agricultural change over the last few decades. Management of relatively flat, fertile land has been progressively intensified, with mechanisation leading to increased field sizes, removal of boundary vegetation, and increased application of agrochemicals. In contrast, traditional farming systems on marginal land, where possibilities for mechanisation are limited due to steep or inaccessible terrain, have been abandoned. These changes have been driven by market forces, socioeconomic development, innovated farm technology and agricultural policies, which aimed at increasing production and efficiency. It was at this time that it became clear that there were lesser possibilities for highlands to enter a dynamic and wide market. Evidence of this is shown by a sharp population decline, shrinkage of the farming area and a drop in livestock numbers. As a consequence, the abandonment of farmland from one side, and the intensification from the other side produce changes in landscape and biodiversity modification. It is at this time that appears the traditional land use system, aiming at preserving landscape and biodiversity and promoting stability by buffering fluctuations, although its productivity was low compared with intensive forms of agriculture. Policies aiming at preserving lands from being abandoned should take into account the individual needs and characteristics of each system, for more targeted and efficient actions.

Keywords: Abandonment, marginal areas, landscape, biodiversity

Riassunto

In tutta Europa ci sono state due tendenze contrastanti nei cambiamenti agricoli nel corso degli ultimi decenni. La gestione delle aree fertili in pianura è stata progressivamente intensificata, con la meccanizzazione, aumentando le dimensioni delle aziende agricole, e come conseguenze, la rimozione della vegetazione di confine, e la maggiore domanda di prodotti agrochimici. Al contrario, i sistemi agricoli tradizionali delle aree marginali, dove le possibilità di meccanizzazione sono limitate a causa dei terreni di alta quota, pendenti o inaccessibili, sono stati abbandonati. Questi cambiamenti sono stati provocati dalle esigenze di mercato, dallo sviluppo socio-economico, dall'innovazione delle tecnologie agricole ma anche dalle politiche agricole, che mirano ad aumentare la produzione e l'efficienza. E' stato in questo momento che è apparso chiaro che non c'erano ampie possibilità per le aree montane di entrare in un ampio mercato dinamico. La prova di ciò è dimostrato da un forte calo della popolazione montana, dal restringimento della zona di allevamento e da un calo del numero dei capi. Di conseguenza, l'abbandono dei terreni agricoli da un lato, e l'intensificazione da un'altro lato, hanno prodotto dei cambiamenti nel paesaggio così come la modifica della biodiversità. E' in questo momento che appare il sistema agricolo/zootecnico tradizionale, volto a preservare il paesaggio e la biodiversità e promuovere la stabilità delle aree aperte, anche se la sua produttività è bassa rispetto alle forme di agricoltura intensiva. Le politiche volte a preservare le aree abbandonate dovrebbero tener conto delle esigenze individuali e delle caratteristiche di ciascun sistema produttivo per un piano di azioni più mirato ed efficace.

Parole chiave: abbandono, aree marginali, paesaggio, biodiversità

Part 1: Marginalization: Processes and consequences

Introduction

In many parts of Europe, two opposing forces have shaped the agricultural landscapes during the last decades: intensification of cultivation in favourable areas and abandonment of marginal areas (*Fjellstad and Dramstad, 1999*). Land abandonment in itself is not a new phenomenon as it has been constant in Europe since 1950. Some events as the industrialisation period at the beginning and middle of the 19th century, wars (World War II) and the Black Death caused the abandonment of entire regions as well as biodiversity decline (*Baudry, 1991; Baldock et al., 1996; Verhulst et al., 2004; Kobler et al., 2005*). Some others such as the Common Agricultural Policy (CAP) reform, the expansion of the European Union, the globalisation, as well as changes in climate and technology (*MacDonald et al., 2000; Gibon, 2005; Giupponi et al., 2006; Mottet et al., 2007*) have participated to its spread. Consequently, traditional land use practices have been in steady decline throughout many of Europe's rural mountainous areas, such as in the Alps (*Giupponi et al., 2006; MacDonald et al., 2000*), in the Spanish Central Pyrenees (*Lasanta-Martínez et al., 2005*), and in various other highland regions (*Höchtl et al., 2005; Gellrich et al., 2007*). In this process, extensive grazing has been reduced, cultivation of low productive lands has been stopped, many of these areas have been afforested, and others were simply abandoned (*MacDonald et al., 2000; Pérez et al., 2003*). Land abandonment could be thus the result and, at the same time, the cause of farm abandonment; understanding both the process of abandonment and its consequences could be a new objective for research.

This chapter reviews and discusses the evidence of the environmental consequences of agricultural land abandonment and of decline in traditional farming practices in mountain zones. The aim is to deepen the environmental implications, in particular on landscape, landscape changes and the subsequent biodiversity modifications, in particular in the European marginal areas. A brief explanation of the major impacts that could have such phenomenon on the environment and its parameters will be given in this first section. More details regarding landscape and biodiversity issues will be introduced in the next section.

Research questions

The main research issues can be summarized as following: What are the consequences of land/farm abandonment in the mountain areas? How will the landscape and biodiversity change in the future? How will they adapt to further changes in society, policy or climate? What special aspects of land use change in the mountain area require consideration, and how should they be addressed? How extensive farming can influence environmental quality and agro-ecosystem biodiversity in the mountains? What is a "multifunctional farming" and how small and extensive-managed farms can get profit from it? Are agricultural policies able to sustain farming systems with diverse management conditions? Are they able to maintain a sustainable use of pastures in marginal areas?

1. Marginal areas

Marginal areas are widespread all over the world. The risk of marginalization is variable from a region to another, and can occur not only due to low profitability of agricultural activities, small size farms or ageing populations, but also because of unsuitable and harsh climatic and topographic conditions (Table 1).

Table 1. Marginal areas: Risk magnitude and main factors.

Affected area	**Main countries**	**LA risks**	**Description- -Main factors**	**Literature**
Atlantic	United kingdom The Netherlands	Low	Small scale fragmented fields	Maskell and Petit, 2004
Mediterranean	Spain France Italy	High	Low profitability of agriculture Small size farms Population ageing	Baudry, 1991; González Bernáldez, 1991; MacDonald *et al.*, 2000; Lasanta-Mártinez *et al.*, 2005
Alpine Sub-alpine Pyrenees	Vosges (France) Corsica (France) Italy (Northern Alps) Slovenia	High	Climatic and geographic conditions Economic and political decisions Small size farms Low income	MacDonald *et al.*, 2000; Tasser and Tappeiner, 2002; Poyatos *et al.*, 2003; Mottet, 2005 ; Giupponi *et al.*, 2006; Tasser *et al.*, 2007; Cocca, 2008
Boreal	Denmark Finland Latvia Estonia	Variable	Fragmented fields Intentional afforestation	Maskell and Petit, 2004
Continental	Czech republic Bulgaria Romania	Variable	Decollectivising and restructuring of post communist lands Agrarian reforms	Maskell and Petit, 2004; Kobler *et al.*, 2005
Pannonia	Hungary	High	Low productivity of agricultural lands	Maskell and Petit, 2004; Verhulst *et al.*, 2004

2. Land/farm abandonment in the context of marginalization

The industrial development of the last decades together with agriculture marginalization has caused important changes in land use. As a consequence, cultivation of low productive lands has stopped, extensive grazing has been reduced and many areas were abandoned. Farm abandonment has affected the most economically developed regions in Spain (Catalonia and Basque Regions (*Romero-Calcerrada and Perry, 2004*)), but 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; Cocca, 2008*). In the same context, 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 abandoned. Similarly, in *Carnia* region, Italy, nearly 67% of the formerly agriculturally used areas have been abandoned too (*Tasser et al., 2007*). According to our findings, agricultural structure change in the Alps was characterized by a dramatic decline in the number of farms in the period between 1980 and 2000 (40%, Table 2). However, the development in the Alpine Area showed different regional trends. While structural change was rather modest in Switzerland, Austria and Germany, it was quite strong in all other States (*Streifeneder et al., 2005).*

Table 2. Changes in farm number, livestock units and livestock density in the EU Alpine areas (period between 1980 and 2000).

	Farms, number			Livestock units, total			Livestock density (Livestock units, total/permanent grassland, ha)		
Country	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	2567,036	3081,705	-39,5	4379,019	4946,37	-17,3	0,9	1,0	-8,9

Source: *Streifeneder et al., 2005*

At the alpine border regions and in Germany, Slovenia and eastern Austria, alpine husbandry is characterised by a high intensity (Table 2). On the contrary there are extremely extensive used regions as 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).*

Abandonment depends on the interaction of physical, environmental, social and economic aspects. This implies that abandonment can occur everywhere, even in areas with a high yield potential, and even in a satisfying general economic situation (*Baldock et al., 1996; MacDonald et al., 2000; Strijker, 2005*). The French term “déprise” which is applied to the current phenomenon, is much broader than the term “abandonment” as it includes any apparent reduction in farmers' stewardship over a large range of spatial and temporal scales (*Burel and Baudry, 1995; Mottet, 2005*). Abandonment can be used in the restrictive sense of “*land no longer used either by agriculture or any other rural economic activity*”. Rather, it means also “*change in land use from the traditional or recent pattern to another, less intensive pattern*”. As a matter of fact, a conversion from ploughed land to permanent grassland, with no or few inputs, can be seen as a form of “abandonment” (*Baudry, 1991; Gibon, 2005; Mottet et al., 2007*).

Abandonment occurs when an agricultural land ceases to generate an income flow and when the opportunities for resource adjustment through changes in farming practices and farm structure are exhausted (*Baldock et al., 1996; MacDonald et al., 2000; Kobler et al., 2005; Strijker, 2005*). Moreover, land abandonment happens when parcels are fragmented and become too small for an efficient agricultural use, when close to city offering an easier life, and because of unfavourable agricultural policies (*Suárez-Seoane et al., 2002; Lasanta-Martínez et al., 2005; Maurer et al., 2006*).

Since the middle of the 20th century, the modernization of farming has led to considerable changes in agricultural systems, resulting in the abandonment of part of the agricultural land and also of some traditional grassland management practices (*Gibon, 2005; Mottet, 2005; Mottet et al., 2007*). These are processes characterised by a step by step reduction of the intensity of land-use per unit of land (*Baudry, 1991; Baldock et al., 1996*). The degree of this specific form of extensification is often determined by location-specific social, economic, political and environmental conditions (*Baldock et al., 1996; MacDonald et al., 2000; Gellrich et al., 2007*).

3. Land abandonment indicators

Abandonment has a variety of causes ranging from direct policies, the indirect effects of pricing making small-scale farming uneconomic, to social changes such as an ageing work-force and reluctance to stay on the land (Table 3) (*MacDonald et al., 2000; Suárez-Seoane et al.,* *2002*). However, the economic and social impacts need to be considered with the environmental effects since we are dealing with a process that influences all elements of the rural system (*Baudry, 1991; MacDonald et al., 2000*).

Table 3. Factors leading to land abandonment.

Physical factors	Management	Landscape	Vegetation	Species
Soil/nutrients Climate Relief/geomorphology Altitude Natural disturbance/fire Water availability Time	Planned Afforestation Fertilisers Grazing Field margins Type of agricultural habitat Pattern of abandonment	Initial composition Landscape context	Past vegetation Litter cover Sward height	Dispersal strategy Regeneration strategy

Source: *Maskell and Petit, 2004*

3.1 Bio-physical conditions

In the European context, lands with physical handicaps have been abandoned or subjected to less intensive land uses (*Jongman, 2002; Pérez et al., 2003*). In particular, *Baudry (1991)* showed that the physical and chemical soil conditions might be of a great importance. Changes in soil texture through erosion, the use of pesticides, the pollution by heavy metals as well as the low content in organic matter of farmed soils respect to the natural ones, have caused the abandonment of agricultural lands (*González Bernáldez, 1991; MacDonald et al., 2000; Kobler et al., 2005; Strijker, 2005*). Moreover, abandonment is mainly depending on aspect, slope and elevation, which can also enhance the probability of landslides (*Tasser et al., 2003*) that might endanger roads and settlements (*Maurer et al., 2006*). In the mountains, where natural constraints are very strong, difficult lands are particularly numerous (*MacDonald et al., 2000; Giupponi et al., 2006*). A study done in the sub-Alpine area of South Tyrol in Italy, precisely in the Passeier Valley, demonstrates that rock-fall sites of very steep slopes in crests and windy locations with shallow and hydromorphous soils were no longer used as pasture and have been abandoned and then covered by various dwarf shrub communities (*Tasser and Tappeiner, 2002*). In Pre-Pyrenees and Alpine areas, the first lands to be abandoned were those in which the conditions for cultivation were the worst, that is, the North and East-facing steep slopes or those situated at higher elevations (*Ihse, 1995; MacDonald et al., 2000; Poyatos et al., 2003; Camacho, 2004; Romero-Calcerrada and Perry, 2004; Kobler et al., 2005; Lasanta-Martínez et al., 2005; Giupponi et al., 2006; Gellrich et al., 2007*). The isolation and physical difficulties have thus limited the capacities for structural and technical adjustment of mountain farming systems (*Mac Donald et al., 2000; Mottet, 2005; Mottet et al., 2007*).

3.2 Structural factors

The literature suggests that structural characteristics in agriculture impact land abandonment (*Baldock et al., 1996; MacDonald et al., 2000*), although predictions for the relationships between related variables are difficult because of conflicting influences. For example, where farms are large, more abandoned land could be expected because of labour shortages. On the other hand, land may be less frequently abandoned on large farms because these farms are generally better equipped (*Giupponi et al., 2006; Gellrich et al., 2007*).

3.3 Social factors

In many marginal areas, livestock production is an expression of the poverty of people who have no other options, and do not have the means to counteract environmental degradation either (*Steinfeld et al., 2006*). In the last centuries, the worsening of the socio-economic conditions for agriculture has led to an increase in the abandonment of agriculturally used areas (*Giupponi et al., 2006; Tasser et al., 2007*). Throughout the Alps, in particular, in the second half of the 20th century, there has been a general exodus and a rural depopulation from the mountains due to the shortage of employment possibilities, the low profitability of agricultural activities, the small size of individual farms and the ageing of agrarian communities (*MacDonald et al., 2000; Romero-Calcerrada and Perry, 2004; Kobler et al., 2005; Mottet, 2005; Giupponi et al., 2006; Tasser et al., 2007*). Moreover, *Baudry (1991), Jongman (2002)* and *Poyatos et al. (2003)* believe that cultural and social aspects e.g. demographic pressure, education and cultural heritage led to an increase in cultivated land and led to abandonment of the uncultivated ones. In reality, since the less productive land is the last being cleared, but the first to be abandoned when it is no longer productive, it is likely that as countries develop socioeconomically, last-cleared areas may be abandoned, entering into a state of recovery towards more naturally-developed vegetation structures (*Pérez et al., 2003*).

3.4 Economic factors

Difficulties in practicing farming in the mountains, low income that could be expected and the attractiveness of employment areas in the plains are all factors that made the mountain agriculture uncompetitive in terms of employment sector (*Mottet, 2005; Giupponi et al., 2006*). Rapid economic changes in rural regions in the second half of the 20th century have led to a general abandonment of mountain agro-pastoral activities (*Poyatos et al., 2003; Romero-Calcerrada and Perry, 2004*). What begins as a partly spontaneous process becomes an administrated process since agricultural productivity is regulated and controlled by government subsidy, by support of infrastructure and by economic control of markets and prices (*Baudry, 1991*). The economically weaker farmers thus, are under pressure and many give up farming or otherwise intensify (*Baudry, 1991; Schmitzberger et al., 2005*). For economists, abandonment occurs when land is no longer used as an economic resource, resulting in an inversion of the land cost/benefit: when the cost of the development of a parcel exceeds the benefit that is reached, the farmer decides to stop this development (*Jongman, 2002; Mottet, 2005; Gellrich et al., 2007*). The abandonment of agricultural activities is also seen through the concept of opportunity cost of labour: if the profit is higher in another area, farmer will cease all his agricultural activity and change job (*Mottet, 2005; Strijker, 2005*). However, there may be sometimes situations that contradict what we have: some farmers continue to operate plots whose operating costs seem excessive, others maintain a small flock when they are full time employed outside and that the revenue generated by their livestock seem insignificant (*Mottet, 2005*).

3.5 Political factors

The impacts of politics on land abandonment can be crucial. The increase in intensive farming that has led to the fragmentation and loss of natural habitats have proceeded in various European farming regions (Table 4), whereas in other less favoured areas there may be widespread land abandonment because of the effects of the Common Agricultural Policy (CAP) reform (*MacDonald et al., 2000; Gibon, 2005; Mottet, 2005; Mottet et al., 2007*). Since the market is not regulated, farmers in the less favoured regions will continue to marginalize (*Jongman, 2002*). For that, regional politics in many EU countries, aiming to maintain rural communities, have provided economic and social incentives to encourage the continuation of marginal farming (*Hunziker, 1995; Fjellstad and Dramstad, 1999; MacDonald et al., 2000; Suárez-Seoane et al., 2002; Gibon, 2005; Mottet et al., 2007*).

3.6 Management and land use

In spatial terms, agriculture is the most widespread type of land use in Europe. It is therefore clear how important agricultural land use changes are for the European environment, in all its varied components (*Giupponi et al., 2006; Mottet et al., 2007*). The "opportunities" or real risks that a parcel moves from one stage to another dependent on what the farmer want to make with it. One can say that an abandoned meadow, except in special cases, get 100% chance of becoming a forest (*Camacho, 2004*). However, as land-use decisions are taken by the individual farmers, the pattern of land management differs from one site to the other (*Tasser et al., 2007*). In a certain sense, the transformation in land use is a result of a shift to a less labour-intensive farming system (*Baldock et al., 1996; Kobler et al., 2005; Giupponi et al., 2006*). In the European mountain areas, former agricultural practices and land use influence the types of species invading abandoned land since arable land is more readily colonized by woody species than are grassland (*Baudry, 1991; Mottet et al., 2007*). Hence, the use of grassland parcels to get enough fodder for cattle indubitably slowed down the abandonment (*Tasser and Tappeiner, 2002; Maurer et al., 2006*), even if 20%, in some areas even as much as 70% of the agricultural land of the Alps has been abandoned (*MacDonald et al., 2000; Giupponi et al., 2006; Cocca, 2008*). The areas, which have been abandoned, were mostly former traditional land use types such as larch meadows and the less intensively used meadows of the subalpine and alpine belt (*Tasser and Tappeiner, 2002; Tasser et al., 2007*). Understanding the processes of land-use change in mountain regions, therefore, is of importance because land-use changes are related to a variety of environmental consequences and significant modifications in mountain landscapes (*Gellrich et al., 2007; Mottet et al., 2007*). Thus, the use of herbicides prior to abandonment (*Baudry, 1991*), the shift of cattle breeding and dairy production from small farms in the semi-open and forested parts to large units in the plains (*Ihse, 1995; Giupponi et al., 2006*) as well as the conversion of unfertilized meadows to extensively grazed pastures (*Camacho, 2004; Maurer et al., 2006*) could be valuable alternatives to abandonment (See Table 4).

3.6.1 Grazing

At a parcel scale, a repeated low rate of grass consumption favours shrubs settlement and spread into grasslands, as a consequence of grazing practices, leading to abandonment (*Camacho, 2004*). In fact, the cessation of grazing results in successional changes towards scrub and woodland (*Baudry, 1991; Kumm, 2003; Camacho, 2004; Acosta et al., 2005; Lasanta-Martínez et al., 2005*). Stockbreeding provides not only income to farmers but in areas heavily affected by afforestation keeps forest from encroaching onto the remaining cultivated land (*Camacho, 2004; Kobler et al., 2005*). But when grazing is reduced, so far, the fragmentation of grasslands occurs (*Ihse, 1995*). In Europe, in the Catalan Pre-Pyrenees area in particular, afforestation and the consequent abandonment of land occurred due to a decline in the sheep population (*Poyatos et al., 2003*). Moreover, a study from the Southwestern Alps showed that grazing by semi-feral goats and browsing by game of young trees such as ash, whitebeam, bird-cherry and beech, are hindering succession towards later successional stages (*Höchtl et al., 2005*). The concentration of grazing in a few highly intensive areas resulted in livestock controlling the increase of vegetation in those sectors, while the rest of the land has been subjected to little pressure, being left to a natural abandonment process (*Lasanta-Martínez et al., 2005*). In fact, abandonment appears to be absent where grazing pressure is high. However, there is no relationship between grazing pressure and abandonment at lower grazing pressure values (*Mottet et al., 2007*). The variability in grazing management practices must therefore be considered to be the source of the different ecological impacts of land abandonment in the landscape (*Lasanta-Martínez et al., 2005; Mottet et al., 2007*).

4. Land abandonment consequences

Negative ecological effects are expected from land abandonment: fire, dereliction, invasion of aggregative species in entropic zones, of weeds and diseases, and biodiversity losses (*González Bernáldez, 1991; Burel and Baudry, 1995; Pérez et al., 2003; Lasanta-Martínez et al., 2005*). However, positive effects of land abandonment could be the increase of landscape heterogeneity, leading to changes in vegetation and in biodiversity at different scales since some species disappear but some other species appear (*Baudry, 1991; Fjellstad and Dramstad, 1999; Kobler et al., 2005; Strijker, 2005*).

Much research, particularly in ecology, conducted in various EU regions have shown that the environmental impact of agricultural abandonment can be serious (*Baudry, 1991; Poyatos et al., 2003; Romero-Calcerrada and Perry, 2004; Höchtl et al., 2005; Lasanta-Martinez et al., 2005*). The abandoning of traditional rural activities have caused rapid changes in land cover which are typical of small cities in many areas of the Mediterranean countries since the end of the second World War (*Poyatos et al., 2003; Romero-Calcerrada and Perry, 2004; Acosta et al., 2005; Gibon, 2005; Giupponi et al., 2006; Mottet et al., 2007*). In areas below the Alpine zone, indeed, the process of abandonment results in dense shrub cover and finally in reforestation (*Tasser and Tappeiner, 2002; Van Eetvelde and Antrop, 2004; Kobler, 2005; Johansson et al., 2007; Tasser et al., 2007;* Table 4). From the ecological point of view, land-use abandonment have a lot of positive impacts on the environment, e.g. lowered inputs of pesticides, fertilizers and water yields, higher carbon sequestration and more stable soils (*González Bernáldez, 1991; Tasser and Tappeiner, 2002; Tasser et al., 2003; Tasser et al., 2007*). Moreover, the abandonment of cultivation in the extensive system has been accompanied by an increase in the number of dwellings and in a study on aesthetic assessment of abandoned agricultural land, *Hunziker (1995)* documented a slight preference for partially re-afforested landscapes, due to their high diversity (Table 4). However, negative consequences from land abandonment are the irreversible loss of traditional cultivation forms, such as alpine and mountain pasturing (*Ihse, 1995; Baldock et al., 1996; MacDonald et al., 2000; Gellrich et al., 2007*), the long-term loss of species rich habitats, threatening the quality of the ecological functioning of landscapes (*González Bernáldez, 1991; Romero-Calcerrada and Perry, 2004; Russo, 2004; Mottet, 2005*) and the higher probability of wildfires especially in dry regions due to the increase of highly flammable fuels (especially abandoned pastureland), the possible homogenization (spatial simplification) of the landscape (*González Bernáldez, 1991; Romero-Calcerrada and Perry, 2004; Mottet, 2005*) as well as the reduction of the diversity of biotopes, thus, having a massive effect on flora and fauna.

5. Cultural landscapes (and biodiversity) consequences

Despite the described effects of abandonment, many rural and cultural landscape characteristics persist. Species-rich grasslands, hay meadows, grazed wetlands and larch meadows are all examples of environmental assets associated with or generated by low-intensity agricultural land-use. Land abandonment therefore leads to a loss of the patchy land mosaic which is often linked to a loss of biodiversity and a clear decrease of the species (*Burel and Baudry, 1995; Giupponi et al., 2006; Tasser et al., 2007*), to a loss of cultural heritage elements, cultural knowledge and local identity (*González Bernáldez, 1991; Tasser and Tappeiner, 2002; Tasser et al., 2003; Van Eetvelde and Antrop, 2004; Friedberg et al., 2006; Tasser et al., 2007*), and from the landscape-aesthetics point of view to a loss of attractiveness (*Hunziker, 1995; Tasser et al., 2007;* Table 4). So far, there are mixed feelings about the consequences of land abandonment. Landscape's wildness has been sometimes judged positively. Thus, a medium degree of spontaneously reafforested land might be assessed positively (*Hunziker, 1995; Höchtl et al., 2005; Mottet, 2005*). The consequences are not entirely negative, at least not in the first succession of trees and bushes, as the edge zones of the forest increase in length. The biodiversity probably increases, but with a shift of species, from grassland species to edge, shrub and woodland species (*Burel and Baudry, 1995; Ihse, 1995*).

Part 2: Land abandonment, Landscape and Biodiversity

Introduction

Abandonment is responsible of the landscape shaping process of rural areas in Europe (*Hunziker, 1995*). The European traditional cultural landscape, evolving from a mosaic of cleared forest patches for agricultural use and originally from old-growth forest patches that were gradually transformed into managed forests, reached an ecological stability that is comparable to that of a natural landscape (*Bätzing, 1991*). However, long-term abandonment undoubtedly leads to reductions in biodiversity (*Fjellstad and Dramstad, 1999*). In this, and similar landscapes, taking good care of what is left and careful planning of locations for habitat restoration are essential (*Fjellstad and Dramstad, 1999; Gibon, 2005; Kobler et al., 2005*).

1. Biodiversity

The abandoning of meadows and pastures in the marginal areas, and elimination of hedges, important wildlife habitat and refuge, as well as banks with natural vegetation in the lowland plains, have all led to loss and fragmentation of habitats with an impoverishment of the typical ecological communities of cultivated environments (*Schmitzberger et al., 2005; Johansson et al., 2007; Kampmann et al., 2007;* Table 4). However, the fear that abandonment of agricultural land will lead to spontaneous succession and a loss of open field species is as widespread as the hope that this trend may provide larger habitats for forest species (*Burel and Baudry, 1995*). The higher species richness and abundance of abandoned grassland may be then explained by their greater heterogeneity and structural diversity (*Russo, 2004; Verhulst et al., 2004; Gibon, 2005*). However, opportunities offered by land abandonment differ according to species. Although some will expand, especially the species with large scale populations, some will contract (open area species), having adverse effects similar to intensification on the conservation, for example, of rare and threatened birds (*Russo, 2004; Verhulst et al., 2004*). The assessment of the ecological consequences of land abandonment, thus, cannot be seen as a simple count of the number of species (*Burel and Baudry, 1995; Fjellstad and Dramstad, 1999; Maurer et al., 2006*). In fact, abandoned sites consisted of a mosaic of grassland and bush suitable for grassland, shrubland and woodland species (*Verhulst et al., 2004*), while in the some Mediterranean regions, land abandonment is a main cause of avian diversity decline (*Molinillo et al., 1997; Suárez-Seoane et al., 2002*). However, local extinction and/or reduction in within-species abundance of birds are expected to continue if the process of land abandonment continues (*Farina, 1997; Russo, 2004*).

2. Landscape

Land abandonment occurs only on parts of landscapes. This heterogeneity refers to the diversity of landscape elements, their fragmentation, frequency, and distribution in space (*Baudry, 1991; Burel and Baudry, 1995; Gibon, 2005*). The transition from a traditional landscape in a new one happens gradually with changes in some landscape components while others remain unchanged (*González Bernáldez, 1991; Eetvelde and Antrop, 2004*).

2.1 Mountain landscape changes

In agricultural landscapes, the intensity of disturbances is greater, the decisions made by people are the main influence on land-use patterns (*Farina, 1997; Höchtl et al., 2005; Mottet, 2005; Maurer et al., 2006*). Traditional agro-pastoral systems had evolved slowly over a long period, a process that shaped typical mountain cultural landscapes (*Giupponi et al., 2006; Mottet et al., 2007*). In mountain areas, the migration to the lowland urban centres, the development of agricultural technology and changes in breeding resulted in landscape closure (*Ihse, 1995; Mottet, 2005*). But changes in agricultural landscapes are not so immediately apparent (*Fjellstad and Dramstad, 1999*). Landscape changes also have implications in terms of available food, hunting areas and habitat for some rare and threatened species causing the homogenization of landscape with the loss of diverse flora and fauna (*Farina, 1997; MacDonald et al., 2000; Suárez-Seoane et al., 2002; Romero-Calcerrada and Perry, 2004;* Table 4). Nevertheless, the intensification of the intensively managed landscape has led to an increasingly homogeneous, large-scale landscape featuring fewer boundaries. In contrast, reduced management in the mountain-farm system has resulted in an increasingly heterogeneous, small-scale landscape (*Fjellstad and Dramstad, 1999; Gibon, 2005*). This connection between micro-level development and macro-level changes in the landscape structures and patterns is of crucial importance for a better understanding of cultural landscape transformation and their ecological impacts (*Hunziker, 1995; Tasser et al., 2007*). In actual fact, landscape simplification in agricultural areas have reduced the recreational value at a time when such landscape qualities are increasingly being recognised as important for modern societies (*Bätzing, 1991; Hunziker, 1995; Fjellstad and Dramstad, 1999; Höchtl et al., 2005*). As a consequence, the new landscapes that have replaced the traditional ones gradually and sometimes abruptly, have led to a loss in the cultural heritage.

2.2 Landscape changes and biodiversity

It is generally difficult to document changes in biodiversity following landscape changes (*Fjellstad and Dramstad, 1999*). However, the relationship between species diversity and landscape diversity suggests that maintaining high plant species diversity at the landscape level requires conserving high land use diversity (*Molinillo et al., 1997; Maurer et al., 2006*). The influence of land use abandonment on the diversity of vegetation types and landscape structures varies depending on the scale of observation (*Höchtl et al., 2005*). Such abandonment and changes in land use are currently a greater threat to biodiversity of arable systems in Europe than the risk of intensification (*Romero-Calcerrada and Perry, 2004*). However, the nature conservationist's view is generally in favour of the present situation of land abandonment, since the mosaic of forests, shrubs and meadows guarantees a high diversity of habitats and therefore high species diversity (Table 4). Partial ingrowth of forest into an agricultural landscape is even assessed as an improvement of its visual quality. However, if the resulting forest patches become too big and homogeneous, a negative feedback can be expected (*Hunziker, 1995*).

2.3 Agro-ecosystem and biodiversity

Understanding and characterizing the relationships between the functioning of agro-ecosystems and biodiversity has become an unavoidable issue to the state of some natural resources but also because of the growing role of multifunctionality of agriculture in the political and societal concerns (*Gibon, 2005; Mottet, 2005*). Field scale dynamics are related to the farming system, the landscape scale changes are driven by changes within or between farming systems, and regional scale dynamics are related to shifts in farming types because of major market or policy changes (*Russo, 2004; Gibon, 2005*). Land abandonment thus, is only one example of the interactions between the dynamics of farming and agro-eco-systems and biodiversity (*Burel and Baudry, 1995*). Although abandonment of extensive farming systems is believed to have negative consequences in terms of biodiversity (*Ihse, 1995; MacDonald et al., 2000; Suárez-Seoane et al., 2002; Gibon, 2005*), species richness and abundance in abandoned ecosystems generally had not decreased. There was a shift, however, from farmland species in extensive ecosystems to shrub and woodland species on abandoned sites (*Molinillo et al., 1997; Russo, 2004; Verhulst et al., 2004*).

2.4 Patches management and biodiversity

An agricultural landscape is not only a set of patches and corridors exhibiting particular patterns in space and time; it is also the space where different farms, hence different farming systems, are mixed and interact (*Burel and Baudry, 1995*). Land abandonment increases heterogeneity if patchy, and/or because physical differences that were hidden by agricultural practices show again. The results are a reduced landscaped variability with a reduced number of habitats, reduced plant diversity and reduced dispersal ability (*Ihse, 1995; Fjellstad and Dramstad, 1999*). Large areas can provide shelter to coarse grain species and to "interior species", but the centre of large abandoned areas will be more difficult to colonize for ground herbs or invertebrates, the benefit of being large will only appear at later stages (*Baudry, 1991; Farina, 1997; Russo, 2004; Lasanta-Martínez et al., 2005*). However, the consequences of reduced connectivity are particularly important in agricultural landscapes since habitat patches are typically small. Each patch alone may be too small to support a stable population, but dispersal amongst a network of patches may enable long-term survival of a species as a metapopulation (*Fjellstad and Dramstad, 1999; Russo, 2004*). This clearly reflects that colonization is a stochastic process operating at individual patch and plant scales rather than as a deterministic process at patch and community scales (*Burel and Baudry, 1995; Molinillo et al., 1997*). Thus, the maintenance of hedgerows is of overriding importance not only to provide habitat to some "corridor species", but to act as a reservoir of species that may colonize abandoned land.

3. Political evolution of the Agro-environment aspect

Many laws and economic incentives can lead to dramatic landscape and biodiversity change and can, therefore, be powerful tools for achieving planning goals (*Fjellstad and Dramstad, 1999*). In the EU, intensification was to a large extent steered by the Common Agricultural Policy (CAP). The CAP was initiated in 1957 with the aim to increase agricultural production, to ensure sufficient food for all inhabitants and a fair standard of living for people engaged in agriculture. The CAP resulted 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; Romero-Calcerrada and Perry, 2004; Verhulst et al., 2004; Gibon, 2005*). 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; Mottet, 2005*).

3.1 Agri-Environmental measures

Several studies have indicated insufficient effectiveness and inadequate evaluation of European agri-environmental schemes (*Kampmann et al., 2007*). Actually, Agri-environment measures, in place since 1992, were designed to encourage farmers to protect and enhance the environment on their farmland (Table 5). They provides for payments to farmers in return for a service, that of carrying out agri-environmental commitments that involve more than the application of usual good farming practice (*EC, 2005*). In more extensive farming areas, the main environmental risk is generally linked to land abandonment, resulting from the abandonment of labour-intensive traditional farming practices important for the preservation of nature. In such areas, measures tend to focus on continuing or re-introducing traditional farming practices with a view to nature protection. Moreover, the EU Agri-environment Regulation have set limits on application of fertilizers to grasslands and offers incentives for extensive use of sensitive areas and the maintenance of biodiversity and landscapes (*Russo, 2004; EC, 2005; Gibon, 2005; Mottet, 2005*). In the wealthier countries, such as Austria, Sweden and Finland, more than 50% of the area is covered by the agri-environmental scheme (*Schmitzberger et al., 2005; Strijker, 2005*). In Hungary, besides, large numbers of farmers have joined the National Agri-Environment Program introduced in 2002 and farmland birds have benefit most from measures aimed at the conservation of existing extensive farming systems (*Verhulst et al., 2004*). This was not always true as in Switzerland, for example, farmers have received lower subsidies for alpine pasturing than for mowing which led to the expectation that forest re-growth occurred more frequently on alpine pastures than on other agricultural land (*Gellrich et al., 2007*) which is in contradiction with what The Swiss General direct payments were intended to do, as ensuring area-wide maintenance of agricultural land and therefore reward farmers' extra efforts due to aggravating topography. Consequently, most of the authors came up with the conclusion that general policy measures for the whole mountain area are not suitable for the prevention of land abandonment, and that they must pay more attention to local characteristics and individual needs of different regions and predominant farming styles (*Schmitzberger et al., 2005; Strijker, 2005; Gellrich et al., 2007; Kampmann et al., 2007*). A summary of such measures in EU Member States is shown in Table 5.

Conclusions

It was proved that the type of soil, slope, exposure, even accessibility, size, etc. are important elements in the land abandonment process, but their importance varies according to the type of agricultural system that characterizes the production unit the field is included in (*Baudry, 1991*). Land is abandoned when the system is stressed by external forces or because of its own dynamics toward extensification or intensification, which is usually driven by economic conditions or the social environment (*MacDonald et al., 2000*). The abandonment of traditional land use systems, especially, results in a loss of pastoral value, soil erosion, fire risk, a decrease in biodiversity and threatened vulnerable species (*Romero-Calcerrada and Perry, 2004; Russo, 2004*). Their abandonment or their conversion to more intensive land use forms usually produce negative effects, because these systems represent very old biological adjustments and balance (*González Bernáldez, 1991*). Traditional land use systems may be thus a source of inspiration for new forms of landscape design and management practices. Research into these ecosystems is important in order to combine their favourable environmental characteristics with technical and social progress (*González Bernáldez, 1991; Hunziker, 1995*). Moreover, the maintenance of livestock production systems typical of mountain agriculture has shown to be the key factor for contrasting land abandonment and the consequent expansion of woodlands (*Giupponi et al., 2006*), but with negative effects in terms of simplification of landscape and impacts on species of naturalistic interest (*Gibon, 2005*). In addition, the homogenization of the land mosaic due to the rural land abandonment has devastating effects on many life forms and ecological processes. As a consequence, it seems that the continuation of traditional agricultural systems depends heavily on direct support from governments. The agri-environmental measures, the compensatory allowances for Less Favoured Areas, further development of cross compliance and modulation, and a variety of nature enhancing measures on the national and regional level, are the most important instruments (*Baudry, 1991; Hunziker, 1995; Jongman, 2002; Russo, 2004; Strijker, 2005*). Furthermore, a reasonable future scenario would be one in which “dynamic, wild areas” coexist with areas of cultural importance. In order to achieve this, existing traditional forms of land use and new, innovative forms should be encouraged and developed (*Russo, 2004; Höchtl et al., 2005*). As well, the encouragement of part-time farming, where some areas are maintained traditionally, simply through the interest and enthusiasm of landowners and volunteers may be a more functional, working solution to preserving these species-rich and internationally important agricultural landscapes (*Fjellstad and*

Dramstad, 1999, Schmitzberger et al., 2005). As a conclusion, profitable farming in the mountains is strenuous and hard to accomplish. However, it is crucial that mountain farming remains economically attractive and ecologically sustainable, to secure the multifunctionality of the agricultural landscape.

Table 4. Recent studies dealing with abandonment, its major consequences on land use, landscape and biodiversity changes and possible solutions.

Author (s)	Study area	Material	Main results
Hunziker, 1995	Lower Engadin Valley, Central Alpine part of Switzerland	Qualitative open interviews	Partial ingrowth of forest into an agricultural landscape is assessed as an improvement of its visual quality. If the forest patches become too big and homogeneous, a negative feedback can be expected. Agricultural policy should prevent old-field succession where spontaneous reafforestation might result in vast homogeneous forest patches.
Giupponi *et al.*, 2006	Belluno province (North-Eastern Italy)	Regional databases from archives, ISTAT, interviews, Aerial photographs, GIS	Maintenance of the livestock prod. sys. typical of mountain agri. is the key factor for contrasting land abandonment and the expansion of woodlands (negative effects on landscape and biodiversity)
Schmitzberger *et al.*, 2005	Austria	Socio-economic survey and biodiversity assessment; official database; interview based on questionnaire	Highly-producing farmers supported the lowest nature values whereas traditionally oriented and innovative farmers carried a higher potential to farm regarding the biodiversity of their landscape
Scozzafava and De Sanctis, 2006	The Rocche Highlands (Abruzzo Region, Central Italy)	Aerial photographs, topographical maps, field survey	The long-term effects of land abandonment are likely to be a loss of habitat for farmland passerine species (red-backed shrike *Lanius collurio*, corn bunting *Miliaria calandra* and yellowhammer *Emberiza citrinella*).
Gellrich *et al.*, 2007	Swiss Alps	Aerial photographs, interviews, field observation, socio-economic survey	Farm labour costs increased faster than incomes, leading to under-grazing and the cessation of tree and shrub clearance
Kampmann *et al.*, 2007	Eastern Central & Northern Alps of Switzerland	Database, official agriculture registers, questionnaire, biodiversity survey; GIS	The co-existence of well-managed pastures and long-term ecological compensation area (meadows) might best conserve mountain grassland biodiversity
Mottet *et al.*, 2007	Villelongue municipality (French Pyrenees)	Interviews with farmers, field survey, GIS	The real agricultural use of parcels (haymaking, grazing, abandonment) determine the level of grassland colonization by ash (*Fraxinus excelsior*)
Tasser *et al.*, 2007	Eastern Central Alps (South Tyrol, Bozen/Bolzano)	Historic photographic material, field work: Land plot assessment (less intensively and intensively used hay meadows)	Seed dispersal and agricultural use are the most important variables influencing natural reforestation. However, grazing and mowing have reduced reforestation. The less intensively the land is used and the longer the area is abandoned, the higher the tree density is.

Table 5. Mountain measures in the implementation of the General Regulation on Rural Development (n° EC/1257/1999) - Period 2000-2006.

Member State	Mountain subcategories for compensatory allowances (Article 18)	Agro-environmental Measures	Other rural development measures
France	High mountain Mountain Piémont	Rhône-Alpes, Aquitaine et Midi-Pyrénées: (maintenance of silvopastoral areas; management of summer meadows in the Pyrenees); Aquitaine: higher levels of aid (zone de l'Ours, zone du parc en Pyrénées-Atlantiques)	
Spain		Practice of transhumance/ migratory herding covers 15 of 17 autonomous communities Support to conserve pasture in mountain areas, to reduce damage when pastures are abandoned Improvement and fertilization of mountain pastures invaded by scrub, watering spaces for livestock, improvement of quality of life and protection of natural spaces and forest Agri-envionmental preservation	Access to mountain pastures as part of the improvement of infrastructure/rural roads Improvement of forest Forest conservation and sustainable forestry management: Improvements of technical forestry-management plans, plant health, reafforestation, infrastructure, preventive forestry
Germany	Steep meadows inappropriate for mechanisation Areas worked by Hand Grassland Arable land	Higher subsidy for the extensification of meadows on steep slopes (> 35%) Environmental use of meadows: distinction between subsidies for mountain and high-altitude meadows and those in humid zones	Regrouping of parcels; maintenance of the existing landscape while assuring better separation between meadows and forests (better use of meadows that are not susceptible to erosion)
Austria	Areas for forage Other areas	Areas for forage Other areas	
Italy	High mountain zone without mechanisation	Measure for alpine meadows: maintenance of mountain farms, of the landscape and prevention of landslides, maintenance of biotopes; intervention in summer pastures with milk processing; maintenance of biotopes and landscape preservation particularly in natural parks	Management of protective forests Article 33: renovation and improvement of villages (buildings and mountain chalets in traditional style; management of sites; management of tourist circuits: wines, gastronomy, cultural)

Note: these measures can be modified. Member States have the possibility to introduce once a year an amendment of their Rural Development programme (Article 44.3, Regulation EC/445/2002).

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Chapter 2

LIVESTOCK SYSTEMS AND FARMING STYLES IN EASTERN ITALIAN ALPS: AN ON-FARM SURVEY

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Abstract

This research aimed to study the relationships between livestock systems, landscape maintenance and farming styles in the Belluno Province, a mountainous area of the Eastern Italian Alps. A total of 65 farms were sampled on the basis of livestock category farmed and herd size. Farms were visited to collect information on technical and productive aspects, on landscape features of land managed, which was identified by aerial photographs and digitised in a GIS environment, and on the farmers' background, attitudes and approach to farming. Six different livestock systems were identified: intensive beef cattle (2 farms); extensive beef cattle (12 farms); large sheep/goat farms (9 farms); small sheep/goat farms (6 farms); intensive dairy cattle (14 farms) and extensive dairy cattle (22 farms). Intensive systems had larger herds, modern structures and equipment, and were strongly production-oriented, whereas extensive systems had smaller herds and productivity, with often traditional or obsolete structures and equipment, but showed a tendency to diversify production by means of on-farm cheese making and/or mixed farming of different livestock categories. The ability to maintain meadows and pastures was greater for the extensive systems, especially in steep areas, while the annual nitrogen output, estimated as kg N/ha, was lower. Data on farmers' background and attitudes were analysed with a non-hierarchical cluster procedure that clustered the farmers into 4 farming styles widely different in motivations to farming, innovative capacity, and ability to diversify income sources and ensure farm economic viability. The farming styles were distributed across all livestock systems, indicating the lack of a linkage between the assignment of a farm to a livestock system and the way the farm is managed. This study demonstrates that in mountain areas the variability of livestock systems may be high, and that they differ not only in production practices but also in the ability to maintain landscape, which is generally higher in the extensive or even marginal systems. Within a given livestock system, farms may be managed with different styles, which implies that informative knowledge to address policy decisions needs to integrate the definition of livestock systems together with the assessment of farming styles.

Key words: Livestock systems, Farming styles, Mountain areas, Landscape maintenance.

Riassunto

Sistemi zootecnici e stili aziendali sulle Alpi Orientali Italiane:
indagine su un campione di allevamenti

Lo studio condotto aveva l'obiettivo di analizzare le relazioni tra sistemi zootecnici, ambiente e stili di conduzione delle aziende nella provincia di Belluno, un'area montuosa sulle Alpi Orientali Italiane. A partire da dati forniti dal Centro Regionale di Epidemiologia Veterinaria (CREV) sono state campionate 65 aziende sulla base dell'indirizzo produttivo e della dimensione aziendale. Gli allevatori sono stati contattati per la compilazione di un questionario, che prevedeva domande relative ad aspetti tecnici e produttivi dell'allevamento. Le superfici gestite dalle singole aziende sono state implementate su cartografia GIS, al fine di individuare ed analizzare degli indicatori ambientali. Infine, sono stati identificati gli stili zootecnici con cui venivano gestite le aziende (farming styles) *sulla base di una serie di domande relative alla formazione e alle motivazioni dell'allevatore. In questo modo sono stati individuati 6 sistemi zootecnici più o meno diffusi sul territorio bellunese: allevamento intensivo di bovini da carne, con sole 2 aziende campionate; allevamento estensivo dei bovini da carne, 12 aziende; allevamenti di ovicaprini di grandi e piccole dimensioni, rispettivamente con 9 e 6 aziende; allevamenti intensivi di vacche da latte, 14 aziende; allevamenti estensivi di vacche da latte, 22 aziende. Dalle analisi descrittive è emerso come le aziende intensive siano caratterizzate da maggiori investimenti in strutture e macchinari, con lo scopo di ottimizzare le produzioni, mentre le aziende estensive sono gestite in maniera più tradizionale, con una maggiore capacità di diversificare l'attività e un maggior ricorso a risorse quali prati e pascoli. L'analisi condotta sugli indicatori ambientali ha messo in evidenza come le aziende estensive gestiscano una maggior superficie di aree aperte a parità di UBA caricate rispetto alle aziende intensive, e di conseguenza l'impatto ambientale in termini di kg N/ha è significativamente inferiore. Risultano inoltre in grado di gestire anche aree più difficili da meccanizzare, in quanto caratterizzate da una maggior pendenza. I dati relativi alla formazione e alle motivazioni degli allevatori sono stati analizzati con una* cluster analysis*, con la quale sono stati identificati 4 diversi stili aziendali: allevatori forzati, biologici, innovativi, e tradizionalisti. Gli stili aziendali sono stati confrontati con i sistemi zootecnici, e non è emersa alcuna relazione tra i due caratteri, a conferma che aziende dello stesso tipo possono essere condotte con stili diversi.*

In conclusione, l'analisi condotta ha evidenziato come nelle zone montane la variabilità dei sistemi zootecnici possa essere ampia, sia in termini di pratiche produttive che di mantenimento delle aree aperte, che è in genere migliore nei sistemi estensivi. Nell'ambito dello stesso sistema zootecnico le aziende possono essere gestite con stili diversi, e questo aspetto dev'essere preso in considerazione nella pianificazione degli interventi gestionali ed amministrativi.

Parole chiave: *Sistemi zootecnici, Stili aziendali, Aree montane, Indicatori ambientali.*

Introduction

In recent decades European agriculture has experienced radical changes, with a decrease in farms number 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 practices (*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; Bielsa et al., 2005; 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*).

Since farming profitability is lower in mountain as compared to lowland areas, and the economic subsidies of agricultural policies have been unable to compensate for this gap (*Bazin, 1995*), it has been suggested that the economic viability of traditional, extensive farming should be promoted through a “multifunctional farming” approach (*Wilson, 2008*). In this approach, the lower productivity of extensive production practices should be compensated by increasing the farm revenues through direct processing and marketing of products, agro-tourism activities, and public contribution for the landscape maintenance and use of environmentally friendly practices (*MacDonald et al., 2000; Bonsembiante and Cozzi, 2005*).

Policies devised to promote the multifunctionality of livestock farming require a detailed knowledge of the existing production systems and of their aptitude to differentiate income sources and maintain/develop landscape maintenance practices. The definition of livestock systems is partly subjective (*FAO, 1995*), but includes structural and technical features that influence production practices, such as farm (herd) size, production type, characteristics of buildings and equipment, level of mechanisation, etc. (*Baudry and Thenail, 2004; Sørensen et al., 2006*).

However, even under similar production conditions and in comparable locations, farms are not necessarily managed in the same way. The observed heterogeneity among farmers (*Schmitzberger et al., 2005*) is in contrast with the common view that agricultural practices are determined only by technology and market, which in fact only constitute the space in which farmers make not uniform but individual decisions (*Van der Ploeg, 1993; Wilson, 1997*). These decisions may have highly diverse consequences on farm management and future evolution, including those on environment and biodiversity. *Van der Ploeg (1993)* defined the farming style as '*…a way in which one has to organise and manage a farm that is generally accepted by a more or less connected group of farmers…*'. The concept of farming style therefore integrates human attitudes, farming objectives and economic success and has proven to be very useful in understanding the heterogeneity in farming management, including the understanding of attitudinal differences regarding landscape strategies (*Van der Ploeg, 1993, 1994; Brodt et al., 2006*).

The aims of this paper were to explore the variability of livestock systems in an alpine area of the eastern Italian alpine region, to analyse their attitude towards landscape maintenance, and to study the relationships between livestock systems and farming styles.

Material and methods

1. Study area

The study area is the province of Belluno (3678 km^2), a prevalently mountainous area with an average altitude of 1276 m a.s.l, located in the most northerly part of the Veneto region, between 45° 50' and 46° 40' N. Land use in the province (*ISTAT, 2002*) is mainly forestry (56.8%) and, less, agriculture (12% meadows and crops, 7.5% pastures and grassland). This province is a clear example of the general trend towards abandoning cultivation, with a decrease in the number of farms and a reduction of cultivated land and of livestock heads (*Sturaro et al., 2005*). The loss of farms was 55% from 1981 to 2001, and that of cattle heads was 24%. These losses were much higher than those observed, on average, in the Veneto region (49 and 19%, respectively; *ISTAT, 1981, 2001*).

2. Sampling scheme and data collection

The livestock farms surveyed were sampled from a general database provided by the Regional Centre for the Veterinarian Epidemiology (CREV), which included information on category of animal farmed and herd size. Only farms with cattle and small ruminants were considered in the survey because other livestock production systems (pigs, poultry, and others) are very uncommon in Belluno Province and their role in landscape maintenance is almost null. In addition, farms with less than 3 livestock units were excluded. Within this dataset (705 retained livestock farms) 65 farms were sampled according to the prevalent category of livestock farmed (14 beef cattle, 36 dairy cattle, and 15 small ruminant) and herd size (within livestock category).

The on-farm survey was based on an interview. Each farm was visited and a questionnaire was filled together with the farmer. The structure of the questionnaire was devised to obtain information on productive aspects of the surveyed farms, such as farm structures and equipment, livestock category farmed (dairy cows, beef cattle, sheep, goats, other), herd size and productivity, on-farm milk processing (if relevant), agro-touristic services, number of employees, and farmer attitudes, such as age, education level, motivations and future prospects. In addition, with the aid of the farmer, the contours of the patches of land managed by each farm were identified on a colour print (1:10.000) of an aerial photograph (*CGR, 2001*) and classified as meadows+pastures or arable crops.

3. Livestock systems and parameters

The definition of livestock systems was based on farm (herd) size and production type, but included other structural and technical features (*Baudry and Thenail, 2004; Sørensen et al., 2006*). When farms were visited, definition of livestock systems was therefore obtained on the basis of breed farmed, productivity, feeding management (maize silage and unifeed *vs* hand feeding of hays and concentrates), characteristics of buildings and equipment and level of mechanisation.

In order to characterise livestock systems, data collected were used to compute the parameters detailed in Table 1. Whenever possible these parameters were expressed as numeric values, otherwise they were expressed as categorical variables (yes/no or classes of value). Livestock units/farm and the employment of people not belonging to the farm family are both indicators of the farm income level. Mixed farming and on-farm cheese making are indicators of the diversification of farm income sources. The status of farm structures and equipment was classified as modern, traditional or inadequate with respect to the category of livestock farmed, the herd size, the available technology and market innovation. Differences in terms of structures and equipment between livestock systems were tested using a χ square test.

4. Landscape maintenance

The contours of open areas used by each farm were digitised using a GIS software (ArcView 3.2®) to calculate their surface. A slope map for each managed land patch was produced by means of GIS (ESRI ArcGIS 9.1®) and a Digital Terrain Model with spatial resolution of 10x10 m (pixel units).

Indexes calculated to analyse the potential role of livestock systems in landscape maintenance are also detailed in Table 1. The total surface managed and its subdivision into meadows, pastures or arable corps was obtained from digitised land patches of each farm. The attitude of managed land to a mechanised management was modelled with a mechanisation index. First, slope was divided into 4 classes (*Benvenuti et al., 2002*): the slope class L (≤35%) can be mechanized using conventional lowland four wheel tractors; the slope class M (>35 and ≤60%) can be mechanised using tractors with four isodiametric wheels and a lower centre of gravity, particularly adapted to work on steep slopes; the slope class H (>60 and ≤80%) requires small tractors carried on a pair of wheels fixed to a single-drive axle; the operator walks behind, gripping a pair of handles. With slopes >80% no tractor units can be used due to safety issues, and agricultural practices can be carried on only by using hand tools. The mechanisation index (MI) was then defined for each patch of open areas on the basis of the proportion of pixels with different slope classes (*Benvenuti and Cavalli, 1996*), as detailed in Table 2. For example, patches with more than 95% of pixels in slope class L were classified as areas of easy mechanisation (MI=1), while patches with less than 95% of pixels in slope classe L, but more than 95% in the classes L+M were considered to need tractors suitable for mountainous terrain (MI=2). Only arable crops and meadow patches were used for this analysis because pastures do not need mechanical support to be managed.

Finally, the annual farm nitrogen output (kg/ha) was estimated by using the official criteria proposed by the Veneto Region (*Xiccato et al., 2005; Veneto Regional Council, 2006*).

The total surface, meadows, pastures and arable crop surfaces/farm, meadows + pastures and arable crop surfaces/LU were compared between livestock systems by using a one-way ANOVA (*SAS, 2003*). Data were log transformed to normalise the distribution. The nitrogen outputs, the proportions of farm meadows and arable crops in each Mechanisation Index were analysed using a non-parametric Kruskal-Wallis one-way analysis of variance with the fixed effects of livestock systems.

5. Farming styles

The heterogeneity among farmers was analysed by using the concept of farming style, defined by *Van der Ploeg (1993)* as '*…a way in which one has to organise and manage a farm that is generally accepted by a more or less connected group of farmers…*'. "Farming styles" of the sampled farms were identified by adapting the "Non Hierarchical K-means clustering" (PROC FASTCLUS, *SAS 2003*). All the information on farmer characteristics and attitudes collected through the interview were included in the analysis: age and educational level, participation to technical courses and livestock/product exhibitions, type of motivation and declared farm prospects. The profiles of each cluster were used to investigate the differences between styles. A χ square test was used to verify if the distribution of farming styles among livestock systems was random.

Results and discussion

1. Livestock systems

Farms surveyed were assigned to 6 livestock systems, as described in Table 3. Differences between systems were significant for herd size ($F=18.2$; df=5; $P<0.001$; data not in table), and status of structures and equipment ($\chi^2=53.5$; df=8; $P<0.001$; data not in table). On-farm cheese making was more frequent in Extensive than in Intensive Dairy farms ($\chi^2=5.1$; df=1; $P<0.05$; data not in table).

Beef cattle farms were divided into an intensive and an extensive system. The intensive system (IntBeef) had only 2 farms. This livestock system, which is based on fattening of young beef cattle, can be found only in the southern part of Belluno province, where climate and slopes are more favourable to agricultural practices (*Sturaro et al., 2005; Cocca et al., 2007*). These farms had a small herd size, as compared to similar systems in more developed areas of the Veneto region (*Sturaro et al., 2005*) and were therefore family-managed, with no use of salaried employees. No mixed farming was observed and structures and equipment were kept up to date. The extensive beef cattle system (ExtBeef) counted 12 farms, with a herd size much smaller than that of IntBeef. Livestock farmed included a combination of suckling cows and their calves, which were fattened with extensive practices and scarce use of concentrates. Only 2 farms make use of salaried employees. Mixed farming was practised by 4 farms. None of the 12 farms had modern structures and equipment. This system is clearly much less specialised and economically sustainable than the previous one. Its spreading in the province can be explained by the low input of manpower and technology, and the possibility to manage it as a part time or secondary employment. It is often a result of the abandoning of the more in-demand dairy production.

The small ruminant farms were widely different in production type (goat and sheep milk, sheep meat) and methods of management. To avoid an excessive fragmentation of the sample, two livestock systems were proposed for small ruminants, based on herd size. Large sheep and goat farms (Large SG) had an average size of 62 LU, with a large variation. Structures and equipment were mostly traditional, and in some cases obsolete. Only one farm, producing goat milk, had modern structures and equipment. The small farms (Small SG) had a very small herd size, and structures and equipment used were prevalently obsolete. Only one small farm directly produced cheese. With few exceptions, SG livestock systems were characterised by very low technological inputs and appear to be able to generate low-level incomes that are really marginal for Small SG.

The dairy farms were divided into two groups: intensive dairy farms (14 units) and extensive dairy farms (22 units). Intensive farms (IntDairy) had large herds where Holstein Friesian prevailed over Simmental and Brown Swiss, they had a high milk production and used large amounts of external feeding supply, mostly with the unifeed technique (data not given in table). Nearly half of these farms made use of salaried employees; none processed on farm the milk produced, and only one did mixed farming. Structures and equipment were always up to date. It clearly represents a very specialised livestock system aimed to maximize the efficiency of milk production with modern feeding and management techniques. The shift towards intensive production practices, where environmental conditions are favourable, has been a general trend in livestock farming in rural areas in recent decades, in the attempt to contrast marginalisation (*Bonsembiante and Cozzi, 2005; Mottet et al., 2006*). Extensive dairy farms (ExtDairy) had mostly a small herd size. The prevalent breeds were Simmental and Brown Swiss, and milk production was generally low (data not given in table). The proportion of farms using salaried employees was similar to that of IntDairy, but one third of farms processed milk into cheese, and/or did mixed farming with beef cattle or small ruminants. This livestock system is clearly more heterogeneous than IntDairy, with less emphasis on efficiency of milk production and technology inputs, and frequent attempts to increase farming revenues through direct processing of milk and/or mixed farming. It comprises traditional farms that have been unable to adopt modern, intensive practices, but also farms that aim to maintain profitability of farming by diversifying income sources instead of intensifying production. In many European rural areas, the development of multifunctional production systems with high quality products is an alternative strategy to create additional revenues to farming (*Wilson et al., 2008*).

The differences between livestock systems regarding landscape parameters are given in Table 4. Total land surface managed/farm was largest for large SG, which used a large surface of pastures. Also IntDairy were able to manage large land areas, but in contrast to large SG most farms of this system made use of a significant surface of arable crops (25 ha/farm), and used small pasture surfaces (11 ha/farm). These land uses are consistent with the need for high concentrate inputs and the low attitude to pasture of the high productive dairy cows farmed. IntBeef, ExtBeef and ExtDairy had similar total land surfaces, significantly smaller than those of the above systems (except for IntBeef). ExtBeef and ExtDairy showed a similar proportion of meadows and pastures used, whereas the pasture was completely absent in IntBeef farms. Again, these differences in land use reflect the gradient in dietary needs of livestock farmed. It might be surprising that, although no hay was used for feeding the fattening beef cattle, IntBeef made use of a significant meadow surface. In fact, the hay produced was marketed and produced a significant increase in farm income. Finally, small SG managed the lowest land areas, mostly as meadows. When the managed surface/farm was standardised for the LU held, both the intensive systems (beef and dairy cattle) used a significantly lower surface of meadows and pasture per LU than the extensive ones ($F=3.9$; $df=5$; $P<0.01$). The analysis of arable crop surface per LU did not show significant differences between livestock systems ($F=1.1$; $df=5$; $P=0.35$): the intensive farms used more arable crops per LU than the extensive ones, but the surface was always of little relevance.

All farmers preferred to use meadows/arable crop patches with MI=1, which corresponds to easy mechanisation with any type of tractor (Table 2). Nevertheless, ExtBeef and ExtDairy were able to manage surfaces with MI=2, which require four-wheel drive forestry tractors. The use of open areas with MI≥3 was almost null, suggesting that these surfaces have been abandoned, although theoretically they can be mechanised.

In general, all livestock systems surveyed here, even the intensive ones, were found to be able to maintain an agricultural landscape composed not only of arable crops but also of meadows and/or pastures. However, the proportion of meadows/pastures to arable crops of the managed land, and the attitude to maintain areas with significant slopes, were higher in the extensive as compared to the extensive systems. This difference is important when is related to landscape changes that occurred in Belluno province as a consequence of the abandoning of livestock farming. The process of re-afforestation has been particularly important for meadows and pastures, while arable crops have been much less affected (*Falcucci et al., 2007*). In addition, the loss of open areas has been much greater in steep areas than in flat ones, which caused a concentration of open areas along the valley bottoms, and an extensive afforestation of the valley' slopes (*Cocca et al., 2007*). This compositional and spatial simplification had diminished the visual attractiveness of the landscape (*Hunziker and Kienast, 1999*). In addition, biodiversity may also be affected, not only because grassland have a greater biodiversity value than arable crops (*Robinson et al., 2001; Giupponi et al., 2006*), but also because the steeper and more extensively managed grassland are those that have the greatest wealth of species (vegetal and animal) (*Marini et al., 2007*).

The estimated nitrogen output/ha (Table 4) never exceeded the threshold of 340 kg N/ha established for the Belluno province, as "a non-vulnerable area" (*Veneto Regional Council, 2006*). However, there were significant differences between livestock systems ($\chi^2=41.3$; $df=5$; $P<0.001$; data not in Table), with the intensive systems showing the highest outputs. Some farms exceeded the 170 kg N/ha threshold established for "vulnerable areas", which could be a problem if in the future the zoning of the province should be revised. The nitrogen output of

ExtDairy was almost half when compared with IntDairy, due to the greater use of meadows and pastures/LU, and ExtBeef and large and small SG had very low outputs.

2. Farming styles

The non hierarchical cluster analysis of farmer attitudes and background data clustered the farmers into 4 different farming styles (Table 5). The first style grouped 13 farmers, which were defined as “Forced farmers” since they were old (62 years of age on average), prevalently of low education level (primary school), not interested in training events and exhibitions, with low economic motivation and with a prospective of maintenance of their activities until retiring and then the closure of same. The second style (13 farmers) was defined as “innovative organic”; it included 8 farmers involved in organic production, and 5 farmers that started agritouristic activities. The mean age was intermediate (50 years), the educational background good (prevalence of high school), their interest in agricultural training, exhibition and events was high, and the declared prospective was positive (maintenance/expansion). The third group (“innovative”, 13 farmers) differed from the second because the choice for organic farming was rare and the mean age was low (33 years), but also they showed the ability to diversify income sources (almost half run an agritouristic activity), high interest in product transformation and economic motivation, and encouraging future prospects. The last style was the most common, with 26 farmers (“traditionalist”). About one quarter of them were part time farmers with another prevalent job; the number of salaried employees was generally low, and they showed no ability or interest in differentiating income sources with agritourism or direct milk processing, although their economic motivation was high. Age, level of education and interest in courses and events were intermediate as compared to the other clusters. They perceived the viability of their farms as uncertain, especially because of the doubts on market evolution.

The farming styles were randomly distributed across all livestock systems (χ^2=18.4; df=12; P=0.43; IntBeef was grouped with IntDairy for this analysis), indicating the lack of a linkage between the assignment of a farm to a livestock system and the way the farm is managed. The same type of farm may be conducted by people with different background, motivation and aims. The implication of this aspect regarding the response of farmers to public policies is evident.

Conclusions

This study showed that livestock systems in Belluno province are highly diversified with 6 different typologies. Dairy milk production remains the most important in the area, but the intensive systems with high technology inputs and high productivity, typical of the recent evolution of livestock farming, are less frequent than the traditional extensive systems. The two systems differ not only for the way of producing milk, but also because, while the activity of intensive systems is limited at producing and marketing milk, that of extensive systems often includes on-farm cheese production and/or mixed farming of other livestock categories. This appears as an emerging strategy to increase farm revenues by diversifying income sources instead of intensifying production practices.

Beef cattle farms are mostly extensive, with small or moderate herd size and the prevalence of suckling cows with extensive fattening of their calves over the intensive fattening of young cattle typical of intensive beef production. Farming in this system is often a residual/marginal activity from a livestock production standpoint. Finally, sheep and goat farms are widely diversified in production type (milk or meat), flock size, and methods of production. Very few of these farms are managed with modern technology and/or large flock size. Their economic role seems to be marginal.

The analysis of landscapes managed by the different systems showed that all of them are able to maintain a surface not only of arable crops but also of meadows and pastures, however, this ability is greater for the extensive systems than for the intensive ones. In addition, only extensive systems maintain meadows located in steep areas, which has important implications since these meadows are at risk of abandonment, contribute to landscape attractiveness, and have high biodiversity values. Intensive systems also showed higher nitrogen outputs/ha/year, although none of them have exceeded the regional thresholds for the area. As a general conclusion, these results indicate that the less advanced and often economically marginal the livestock systems are, the more they contribute to landscape maintenance.

The analysis of farming styles showed that the farmers' background and attitudes are also heterogeneous, with at least 4 different approaches to farming. One group of farmers was defined as "forced farmers", since they have no alternative to farming nor the motivation or ability to improve farming incomes. These farmers will not likely respond to agricultural policies and their farms will be closed. A second, larger group included farmers whose run their farms with higher economic motivations than the forced ones, but still maintain a traditional approach to farming and do not show interest and/or ability to diversify income sources. They would be interested only in policies aimed at sustaining conventional production practices and the future of their activity depends on the market prices of inputs and products. What is most interesting in the results of the analysis of farming styles is, however, that two third of the farmers interviewed demonstrated the interest and the capacity to find new ways of increasing farming income. The subdivision of these farmers into two groups was mainly due to differences in age and the choice of organic instead of conventional production, but both had high economic motivations, the ability to run agritouristic activities and/or produce cheese on farm, and foresee the future of the maintenance or even the expansion of their activities. These farmers are able to ensure, through these additional income sources, the economic viability of livestock farms otherwise destined to future closure, as, for example, extensive dairy or beef farms. Future agricultural policies aimed at sustaining extensive farming and landscape maintenance should be developed while taking into account these tendencies.

The different farming styles are distributed across all the livestock systems. The lack of a linkage between the livestock systems and the way the farms are run has the important implication that informative knowledge to address policy decisions needs to integrate the definition of livestock systems with the assessment of farming styles.

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Table 1. Parameters derived from the on-farm survey to describe the livestock systems and their attitude towards landscape maintenance.

Parameter	Unit	Description
Livestock systems		
1. Livestock Units (LU)/farm	Numeric	Livestock units follow EU livestock schemes: cattle > 2 years and equines =1 LU, cattle 6 months to 2 years = 0.6 LU and sheep and goats = 0.15 LU
2. Employees	Categorical (yes/no)	Indicates whether the farm is managed with salaried employees (yes) or only with the owner/family manpower (no)
3. Mixed farming	"	Mixed farming occurs (yes) when at least 30% of the total LU farmed is represented by a livestock category different from the main category farmed
4. Cheese making	"	Indicates whether the milk produced is sold (no) or processed directly on farm and sold as cheese (yes)
5. Structures and equipment	Categorical (M/T/I)	Farms structures and equipment were scaled as modern (M), traditional (T) or inadequate (I), according to an evaluation based on livestock category, herd size and available technology
Landscape maintenance		
1. Total surface/farm	Numeric (ha)	The total open areas surface managed by the farm: meadows, pastures and arable crops
2. Meadows/farm	"	The surface of meadows managed by the farm
3. Pastures/farm	"	The surface of pastures managed by the farm
4. Arable crops/farm	"	The surface of arable crops (mainly maize) managed by the farm
5. Meadows+pastures/LU	Numeric	As above, divided by the LU of the farm
6. Arable crops/LU	"	As above, divided by the LU of the farm
7. Mechanisation index	" (% tot. surface)	The proportion of arable crops+meadows of each farm that can be mechanised with machinery of increasing adaptation to slope (see text and table 2 for details)
8. Nitrogen output	Numeric (kg N /ha/year)	Calculated on the basis of regional tables (*Xiccato et al., 2005*).

Table 2. Mechanisation index (MI) of open area patches.

MI	Percentage of pixels within mechanisation classes[1]	Mechanisation management
1	L > 95	Any type of tractor
2	L+M > 95	Need for four-wheel drive forestry tractor
3	L+M+H > 95	Need for walking tractor
4	75 < L+M+H < 95	Need for four-wheel drive forestry tractor or walking tractor and limited use of hand tools
5	50 < L+M+H < 75	Need for great amount work with hand tools. The use of four-wheel drive forestry tractor or walking tractor is limited
6	L+M+H < 50	Not mechanisable

[1]: L=pixel slope ≤35%; M=pixel slope >35 and ≤60%; H=pixel slope >60 and ≤80%. With slopes >80% no unit tractor can be used with respect to security issues. Agricultural practices can be carried out only by using hand tool.

Table 3. Descriptive statistics of Livestock Systems.

Livestock. System	N. of farms	LU[1]/Farm	No. of farms with			Structures & Equipment (%)[3]		
		Mean (min-max)	Salaried employees	Cheese making	Mixed farming[2]	M	T	I
IntBeef	2	174[a] (119-230)	0	0	0	2	0	0
ExtBeef	12	15[d] (3-39)	2	0	4	0	5	6
Large SheepGoat	9	62[b] (17-225)	1	0	1	1	5	3
Small SheepGoat	6	6[d] (2-15)	0	1	1	0	1	5
IntDairy	14	147[a] (63-347)	6	0	1	14	0	0
ExtDairy	22	30[c] (3-122)	9	8	7	4	12	6

[1]Livestock units follow EU livestock schemes where cattle >2 years and equines=1 livestock unit (LU), cattle 6 months to 2 years=0.6 LU and sheep and goats=0.15 LU.
[2]farm with more than one species/category of livestock farmed.
[3]M=modern; T=traditional; I=inadequate.
Means with different superscripts within column differ significantly: [a,b,c, d]=P<0.05.

Table 4. Landscape maintenance parameters of Livestock Systems.

Livestock System	Managed surface/farm ha (SD)					Managed surface/farm/LU[1] ha(SD)		Meadows/crops mechanisation index (% of surface)			No. output Kg N/ha (SD)
	Total	Meadow	Pasture	Arable crop N. farms	Arable crop Ha (SD)	Meadow + pasture	Arable crop	1	2	≥3	
IntBeef	48^{ab} *(31)*	38^{a} *(20)*	/	2/2	10^{b} *(12)*	0.27^{b} *(0.24)*	0.08^{ns} *(0.10)*	/	/	/	126^{a} *(21)*
ExtBeef	35^{b} *(43)*	15^{b} *(16)*	20^{b} *(34)*	3/12	1^{c} *(0)*	2.24^{a} *(2.29)*	0.02^{ns} *(0.06)*	63^{b}	36^{a}	1	40^{c} *(25)*
Large SheepGoat	82^{a} *(81)*	20^{b} *(19)*	62^{a} *(83)*	2/9	2^{c} *(2)*	1.28^{a} *(0.97)*	0.02^{ns} *(0.05)*	91^{a}	9^{b}	0	7^{d} *(14)*
Small SheepGoat	10^{c} *(6)*	8^{b} *(4)*	1^{c} *(1)*	3/6	2^{c} *(2)*	1.60^{a} *(0.98)*	0.05^{ns} *(0.09)*	91^{a}	9^{b}	0	9^{d} *(20)*
IntDairy	80^{a} *(24)*	55^{a} *(24)*	11^{b} *(16)*	8/14	25^{a} *(15)*	0.58^{b} *(0.28)*	0.09^{ns} *(0.09)*	92^{a}	8^{b}	0	133^{a} *(62)*
ExtDairy	40^{b} *(40)*	22^{b} *(23)*	17^{b} *(27)*	3/22	7^{b} *(4)*	1.61^{a} *(1.27)*	0.02^{ns} *(0.07)*	77^{ab}	21^{ab}	2	75^{b} *(60)*

[1]Livestock units follow EU livestock schemes where cattle >2 years and equines =1 livestock unit (LU), cattle 6 months to 2 years =0.6 LU and sheep and goats =0.15 LU.
Means with different superscripts within column differ significantly: $^{a,b,c,\ d}$=P<0.05

Table 5. Profiles of farming styles identified with cluster analysis.

Variable	Farming style 1	Farming style 2	Farming style 3	Farming style 4
No. of farmers	13	13	13	26
No. of part time farmers	2	1	0	8
No. of organic farms	-	8	2	1
No. of agritourisms	-	5	6	-
No. of employees (mean ± SD)	1.7 ± 0.9	1.8 ± 1.3	2.4 ± 1.5	1.6 ± 1.4
Age (mean ± SD)	62 ± 7	50 ± 6	33 ± 7	42 ± 8
Education level (prevalent)	Low	High	Intermediate	Intermediate
Training and events	Low	High	High	Intermediate
Economic motivation	Low	High	Intermediate	High
Interest in products transformation	Low	High	High	Low
Farm prospective	Closure Maintenance	Maintenance Expansion	Expansion	Maintenance Uncertain
Cluster definition	Forced farmers	Organic	Innovative	Traditionalist

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Chapter 3

THE ALPINE SUMMER PASTURES IN THE VENETO REGION: MANAGEMENT SYSTEMS

Abstract

The aim of this study was to identify the management systems of the alpine summer pastures (SP) of the Veneto region and their geographical distribution, by means of detailed questionnaires on 485 holdings. The on farm survey consisted of gathering information regarding logistic and technical aspects of the summer pasture unit as well as data related to economic and productive characteristics. A non-hierarchical cluster analysis was implemented and we were able to identify 7 different management systems: 1: milk production, 2: cheese production, 3: agritourisms, 4: disadvantaged holdings; 5: holdings with dry and replacement cows; 6: summer pastures of both dry cows and small ruminants; and 7: long summering pastures. The different groups showed a clear tendency to concentrate spatially in different portions of the study area. Moreover, an economic study conducted on the sampled summer pastures and consisting in developing some synthetic indicators for studying the convenience or inconvenience of a given management system have demonstrated the variability of these latter. Regional policies should consider this variability to better sustain the alpine summer pasture management systems.

Keywords: alpine summer pastures, livestock systems, Alps.

Riassunto

L'obiettivo di questo studio era di identificare i sistemi di gestione degli alpeggi estivi della regione Veneto e la loro distribuzione geografica, per mezzo di questionari dettagliati su 485 malghe. L'indagine consisteva nella raccolta di informazioni relativi gli aspetti logistici e tecnici delle unità malghive, nonché i dati relativi alle caratteristiche economiche e produttive. Una cluster analysis non gerarchica è stata attuata e siamo stati in grado di individuare 7 diversi sistemi di gestione: 1: malghe per la produzione di latte, 2: malghe con produzione di formaggio, 3: agriturismi, 4: malghe svantaggiate; 5: malghe con vacche in asciutta; 6: malghe con vacche in asciutta e piccoli ruminanti, e 7: malghe con lunga monticazione. I diversi gruppi hanno mostrato una chiara tendenza a concentrare spazialmente in diverse parti dell'area di studio. Inoltre, uno studio economico condotto su un campione di malghe e che consiste nello sviluppo di alcuni indicatori sintetici per lo studio del vantaggio/svantaggio dei sistema di gestione identificati hanno dimostrato la variabilità di questi ultimi. Le politiche regionali dovrebbero considerare questa variabilità per meglio sostenere le malghe e i loro sistemi di gestione.

Parole chiave: malghe, sistemi di gestione, Alpi.

Introduction

Summer pasturing is one of the most traditional and oldest forms of economic use in the alpine areas (*Moser and Feliciani 1974; Polelli, 1974; Berni and Fabbris, 1983; Del Favero et al., 1990*). Summer pastures (SP), especially in the past, have carried out a key role and an important function in the alpine farming, allowing the integration of the forage availability in the lowland with that of high elevation pastures (*Usai et al., 2006; Marini et al., 2008*). Moreover, the alpine summer pastures are still one of the most interesting historical and cultural landscape of the alpine area, representing a social heritage whose importance goes far beyond their ability to provide a direct income to the farmer or, more broadly, to people who work there (*MacDonald et al., 2000; Manrique et al., 1999; Pasut et al., 2006*). At the change of the mountain economy and the gradual emergence of a multifunctional role of all the agro-pastoral and forestry activities (*Gibon, 2005; Giupponi et al., 2006; Mottet et al., 2007*), the summer pasture role has also changed. In particular, the evolution of livestock farming systems in mountain has been heterogeneous and has depended on multiple specific factors of technical, economical, environmental and social importance (*MacDonald et al., 2000; Gibon, 2005; García-Martínez et al., 2008*). Traditional livestock farming systems have and still exist here and there in the Alps (*Berni and Fabbris, 1983; Sturaro et al., 2005; Pasut et al., 2006; Venerus et al., 2007*), being the major source of income for the mountain population. Considering as a reference, in particular, the context of the pre-alpine and alpine areas of the Veneto Region, North-eastern Italian alps, summer pastures management are considered to be an important issue for the ongoing of the traditional mountain farming. Previous studies of alpine summer pasture management systems had been performed (*Moser and Feliciani, 1974; Polelli, 1974*) and in particular in the Veneto region (*Berni and Fabbris, 1983*), showing the importance of summer pasture systems from an economic, environmental and social point of view. Many recent studies dealing with the traditional grazing systems and mountain pasturing (*Ziliotto et al., 2004; Sturaro et al., 2005; Giupponi et al., 2006; Pasut et al., 2006; Cocca et al., 2007; Cocca, G., 2008; Mrad et al., 2008; Koroschitz et al., 2009; Mrad et al., 2009b*) are also trying to respond to some issues regarding the role that could play such systems in the landscape and biodiversity maintenance, as well as the conservation of the traditional and cultural heritage and the enhancement of the economic and social conditions of the mountain population. This chapter is going to answer to some of these queries, providing some solutions for a better and sustainable use of the alpine pasture resources of the Veneto region.

Objectives

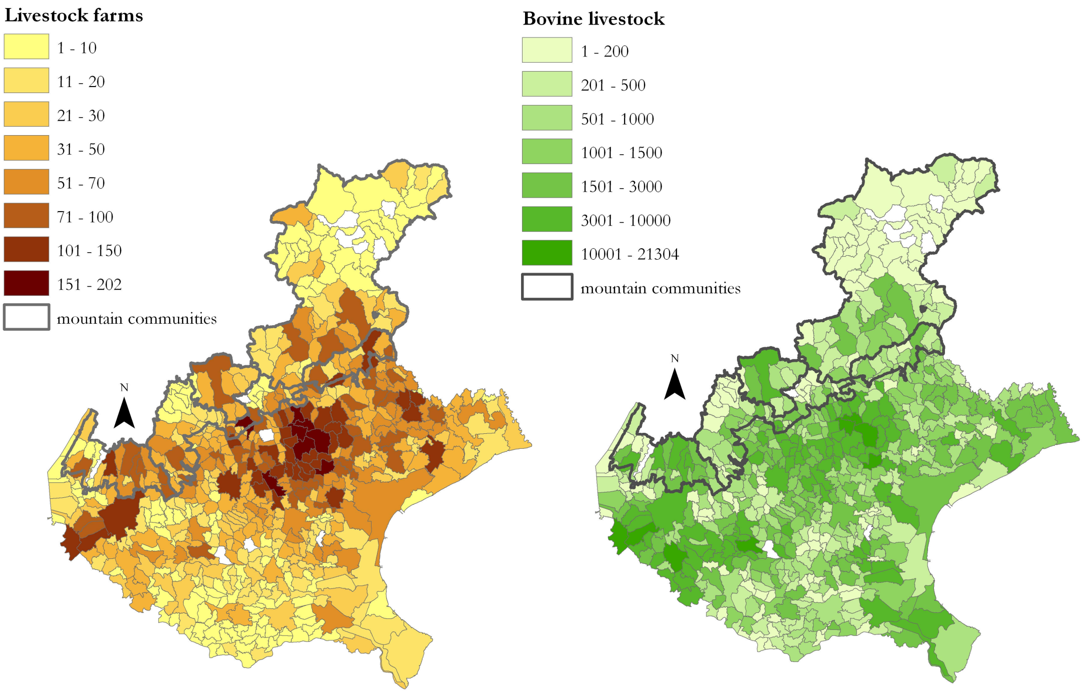
The objectives of the present work are to analyse the mountain area of the Veneto region to update the information that we already have regarding the summer pastures, from the last census done in the 80's, to obtain a better knowledge of the reality of the livestock production sector, which is important for the ongoing of the mountain economy in the North-Eastern part of Italy, an Alpine area considered to be a Less Favoured Area (LFA); to detect the main characteristics of the different types of summer pastures existing in the region; to observe the evolution trends of the different farming systems and to characterise them by applying a multivariate approach, as well as their geographic distribution amongst the study area; and finally to plan different actions through the development of economic indicators, leading to improve the profitability of the existing systems, and at the same time, to enhance the sustainability of the vulnerable ones.

Material and methods

The study area (approximately 4660 km^2) corresponds to the 173 municipalities of the Veneto region (18406 km^2) classified as mountainous, and belonging to 19 mountain communities listed here as following: *"Agno-chiampo", "Agordina", "Alpago", "Alto astico e posina", "Astico-brenta", "Baldo", "Belluno Ponte nelle Alpi", "Brenta", "Cadore-Longaronese-Zoldano", "Centro cadore", "Comelico e Sappada", "Feltrina", "Grappa", "Leogra-Timonchio", "Lessinia", "Prealpi trevigiane", "Spettabile Reggenza dei Sette Comuni", "Valbelluna" and "Valle del Boite"*. The area of study (25,3% of the Veneto region total area, Figure 1) is characterised by a particular and highly variable climatic and topographic conditions, the mean elevation is of about 1380 m a.s.l. with a minimum of 646 m a.s.l. and a maximum reaching 2213 m a.s.l. (ArcGIS 9.2®). This area in particular, being mountainous, has been subject to a decline in livestock farms as well as a reduction in livestock units per farm (Figure 1), and a general abandonment of farming practices, especially between 1980 and 2000 (*Berni et Fabbris, 1983; ISTAT, 2002; Giupponi et al., 2006; Cocca et al., 2007; Cocca, 2008*).

An alpine summer pasture is defined here as a holding where livestock are moved over summertime from the lowland permanent farms to exploit the pastures (*Ziliotto et al., 2004; Pasut et al., 2006*).

Figure 1. Livestock farms and bovine livestock distribution within the Veneto region and mountain communities.

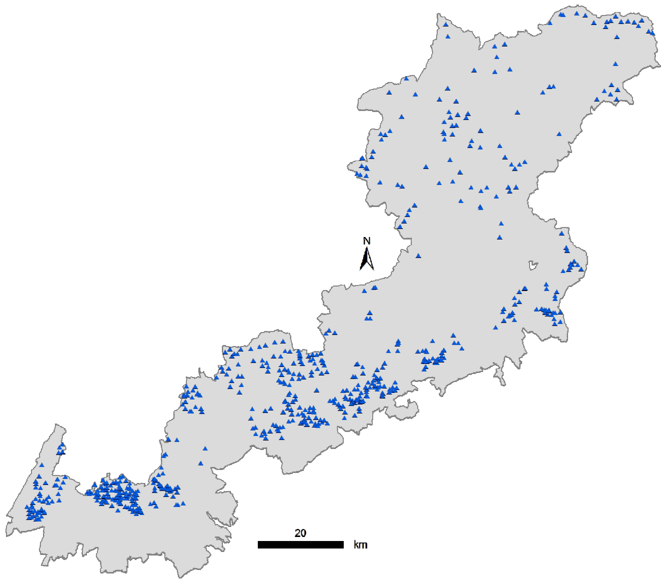


Source: ISTAT, 5° Censimento dell'Agricoltura, 2002.

Information on alpine summer pastures were collected and edited from regional (Official databases from the Veneto Region), local (mountain communities and municipalities, various ASL[*] and ULSS[*]) and veterinary (CREV[*]) databases. This produced an updated database of 701 alpine summer pastures with their location (Figure 2), ownership (306 public, 362 private individual, and 33 private collective), and present status (536 active and 165 abandoned). A previous study done by *Berni and Fabbris* (1983) have identified 618 alpine summer pastures of which 503 were active SP, our survey have permitted to identify 6% more of active SP, especially those of private ownership. However, almost all SP that were active in the 80's are still in use nowadays even if in some cases the type of use has changed. A sample of 485 out of the 536 active holdings was then surveyed by interviewing the farmer to fill in a questionnaire on logistic (accessibility, availability of water, electricity, housing, etc.), productive (livestock held, milk processing, equipment and machinery, etc.), and economic (agri-touristic activity, direct products retail) features. Questionnaires of detailed level (346 SP) were compiled by the interviewer during the visit to the SP. The aim was to detect with reliability and timeliness and by direct contact with the conductors and through the interview, the real situation of the retained SP sample for the features listed below (Table 1, Table 2 and Table 3). Questionnaires of intermediate level (139 SP) were done by phone conversation or sent by mail. For the remaining SP (51), it was not possible to gather the data and/or contact the SP conductor.

** ASL: Azienda Sanitaria Locale (Local Sanitary District); ULSS: Unità Locale Socio Sanitaria (Local Unit for Social and Sanitary Services); CREV: Regional centre for Veterinary Epidemiology*

Figure 2. Summer pastures distribution within the study area



Many recent and less recent studies have adopted the on-farm survey techniques to study the livestock systems and similar approaches were used to study the agricultural management systems (*Moser and Feliciani, 1974; Berni and Fabbris, 1983; Castel et al., 2002; Pasut et al., 2006; Usai et al., 2006*). A summary of the variables studied with a brief description is given in following:

1. Infrastructural and structural circumstances (accessibility, buildings, equipment, etc...).
2. Technical and economic parameters (workforce, product sales and marketing, services offered, etc…). This section has been widely discussed before being adopted. Given the impossibility of obtaining direct economic data (as the profit from product sales, SP revenues from the agri-touristic activity, the actual costs for salaries, etc...), we aimed to have a range of analytical information about the staff (full-time and part-time, family managed and employee) used in various functions (to differentiate those traditional SP from the most recent ones), the type and level of services offered, etc...
3. Pasture status (production-management): mapping identification (ortophotographs of 1:10.000 resolution) of livestock grazing areas so as to define the grazing system (free/continuous, seasonal/patchy, Rotational) for different categories of summered herds: each section was then evaluated using various parameters (under/over-grazed areas, weed encroachment levels, etc...). This assessment was integrated with the mapping identification and description of:
    - Internal roads, fixed fences, elements of scenic/natural interests (dry stone walls, historic buildings, large trees, wetlands, etc.). This together with the construction type of buildings can contribute to value the landscape/natural pastures.
    - Livestock number, typology and status (production, physical fitness and body condition, nutrition supplement, etc.). These indicators may be useful in assessing, for example, the adequacy of the stocking rate or the inclusion of the breeding cattle in the SP environment, or be used to calculate some indirect economic indicators.

Statistical analysis

Several datasets were combined to provide the materials used in the construction of the final database considered for the statistical analysis. The main variables considered in the interviews and used for the preliminary descriptive analysis are listed in Table 1, Table 2 and Table 3. Some variables were not directly included in the questionnaires but resulted from calculation based on the original variables. Means and standard deviations (continuous variables; data not in tables) or frequencies (categorical variables) were calculated for the most informative variables (Tables 1, 2 and 3).

Data collected were then edited and analysed with the non-hierarchical clustering technique FASTCLUS (SAS, 2006) which is well indicated in the multivariate analysis of large datasets and is able to limit problems of redundancy and outliers (*Nargundkar and Ozler, 1998; McGarigal et al., 2000; Usai et al., 2006*). Similar approaches were used by *Weigel and Rekaya (2000)* and *Zwald et al. (2003)* to cluster cattle herds.

The same database of 485 records was used to group the summer pastures surveyed on the basis of their main structural, managerial and farming characteristics. Preliminary results regarding the actual SP status of the Veneto region as well as their management systems were published during the ASPA Congress (*Mrad et al., 2009b*). The SP sample considered for that study was of about 417 units, and we were able to identify 5 different clusters corresponding to 5 different management systems in Veneto region (*Mrad et al., 2009b; see Appendix I*).

In this chapter, indeed, we are going to deepen the analysis by implementing the number of SP surveyed (485 SP in total were retained) and we are going to increase the number of variables used and check if the summer pasture management typologies will be different respect to the first analysis.

Summer pastures merged and managed by the same operator as a single unit were treated as one entity.

The information was coded as binary (dichotomous) and continuous variables. In particular, data relating to summering days and the number of workers are presented as continuous variables (Table 5), and were standardized in order to compare them with other information collected. Other binary variables were then used, coded as 1 if present or 0 if absent:

- Private or public SP ownership;
- Accessibility via normal car, SUV, tractor or on foot. Some SP, for example, have access roads used for a short distance by car and then, for a stretch, in other ways;
- Personnel residing in SP during summer.

- Availability of potable water, of power line electricity, only through electricity generator, and the presence of alternative sources of energy;
- Availability of housing for staff;
- Bar, restaurant or accommodation for tourists *in situ*;
- Milking (hand milking, pipeline, parlour or bucket);
- Presence of milk cooling baths/refrigeration tanks;
- On-farm cheese making;

The type of livestock has been classified as follows: dairy cattle, dry/replacement cattle (dry cows, heifers, calves, suckling cows), fattening cattle (beef and fattening heifers), sheep and goats (Table 5). The overall stocking rate of alpine SP was estimated as LU calculated as the total livestock present on pasture during the summering period, inclusive of cattle (dairy cows; LU=1, heifers and veal calves; LU=0,6; dry and suckling cows; LU=1), sheep, goats; LU=0,15 each; and horses; LU=1 (*CEC, 1975; DGR, 2002; Mrad et al., 2009a; Sturaro et al., 2009*). Stocking rate percentage was then obtained considering the four categories specified above. The calculation did not consider all the other categories of animals; SP that have not loaded cattle or sheep and goats were in fact only 8. The percentage of LU given by each category was included as a variable in the cluster analysis (Table 6).

The optimal number of clusters was chosen on the basis of the cubic clustering criterion (CCC) statistic (*Nargundkar and Ozler, 1998; McGarigal et al., 2000; Zwald et al., 2003; Usai et al., 2006*). In order to characterise and compare the identified clusters, the main descriptive statistics were calculated for each of them (Table 5 and Table 6).

Results and discussion

1. Summer pastures: Descriptive analysis

1.1 Ownership, infrastructure and logistic aspects

The main descriptive statistics regarding the structural aspects of summer pasture units of the Veneto region, consisting in the principal variables that were retained valuable for the descriptive analysis and the SP frequencies, are listed in Table 1. Summer pastures are owned just under half of the total by public institutions while almost 60% (253 SP over 485) corresponds to private establishments. These latter are almost all owned by individual persons, although in some cases the properties are hold by two or more owners. Rather, collective ownerships such as "Regole" and/or farmers cooperative exist. Regarding the SP accessibility, we found that more than 80% of SP (393 SP over 485 in total) are reachable with a normal car (Table 1), and therefore, for simplicity, other possibilities to arrive *in situ* were joined (by means of SUV, tractor, or on foot; less than 20% of total). Concerning the mean elevation of each SP, a Digital Elevation Model (DEM, 10 x 10 m resolution) was calculated in GIS (ArcGIS 9.2 ®) taking the coordinates of the SP holding site as a reference and then calculating the mean elevation for each pasture. We choose then to classify it into 3 main classes, based on the variability distribution of the considered variable (Table 1). Over 50% of the georeferenced SP elevation is between 1200 and 1600 m a.s.l., roughly 20% of SP units falls in that under 1200 m a.s.l. (94 SP over 485) and the remaining belong to the interval above 1600 m a.s.l. (118 SP). As expected, based on the morphology and geographic characteristics of the territory (*Sturaro et al., 2005; Giupponi et al., 2006; Cocca, 2008*), this distribution hides significant differences between the mountain communities and all over the Veneto alpine territory, with the southern part showing a concentration of SP of low elevation intervals, and the northern one (North Belluno, in particular), showing the opposite trend (differences in geographic distribution amongst the region will be discussed later on). However, the mean elevation interval (1200-1600 m a.s.l.) mainly present, correspond to the average elevation values of the mountain pastures and meadows and characterise well the alpine territory (*Berni and Fabbris, 1983; Ziliotto et al., 2004; Pasut et al., 2006; Gellrich et al., 2007; Koroschitz et al., 2009*).

Table 1. Active structural variables used in the cluster analysis

Variable	Classes	*N*
Ownership		
Public	Yes public/No private	232
Private	Yes private/No public	253
Access to a road		
Normal car	Yes normal car/No other	393
Other	Yes other/No normal car	92
Elevation* (m a.s.l.)		
Elevation (l)	<1200	94
Elevation (m)	1200 - 1600	259
Elevation (h)	>1600	118
Total manpower* (AWU)[1]		
AWU (l)	<1	193
AWU (m)	1 - 2	210
AWU (h)	>2	79
Resident *in situ* during summer		
Resident	Yes resident/No commuter	266
Commuter	Yes commuter/No resident	219
Equipment		
in situ Machinery yes	Yes machinery	157
in situ Machinery no	No machinery	328
Facilities*		
Watering yes	Yes watering	354
Watering no	No watering	131
Electricity yes	Yes Electricity	371
Power line	Yes Power line	317
Generator	Yes Generator	41
Alternative energy**	Yes Alternative energy	53
Electricity no	No Electricity	114
Available housing yes	Yes Available housing	431
Available housing no	No Available housing	54
Services (Agritourism)*	Yes Agritourism	81
Only Bar yes	Yes Bar	17
Only Restaurant yes	Yes Restaurant	27
Bar and Restaurant yes	Yes Bar and Restaurant	18
Bar & Restaurant with accommodation	Yes Bar & Restaurant with accommodation	19

N: number of summer pastures surveyed.
(l): low; (m): medium; (h): high.
AWU: Annual Working Unit.
[1]: AWU was standardized for the summering period (The average summering period was fixed at 120 days).
* Missing data occurred.
** Alternative energy available alone or associated with some other energy source.

1.2 Staff employment and services offered

Commenting on the total manpower operating in SP during the summering period, it can be noted that over 45% of the SP are operated by staff who does not reside there (daily commuters; 219 SP over 485). This choice is particularly frequent in some mountain communities ("Lessinia" and "Baldo" (80%)) but not in others (data not listed in tables but discussed later on). These pastures are usually close to the farm site, where animals can be treated and managed with a daily visit. Regarding the number of total employees (including part-time workers), here reported as AWU (Annual Working Unit; *EC, 2009*), and standardized for the summering period (see table 1; the standard summering period was fixed at 120 days), SP with less than 1 AWU include approximately 40% of the sample, those between 1 and 2 AWU another 45%, and less than 15% of SP employed 2 or more AWU, explaining the scarcity in manpower operating in the mountain areas, preferring to move and look for an easier life in the lowlands and cities, leading to the abandonment of the mountain farming activities (*Polelli, 1974*; *Manrique et al., 1999; MacDonald et al., 2000; Giupponi et al., 2006; Cocca, 2008*). Regarding SP equipment, a good percentage of farmers (just under 35%) held *in situ* machinery (mainly tractors), considered to be an important indicator of intensification of the farm activities (*Benvenuti and Cavalli, 1996*). Those of some mountain communities ("Baldo", 95%, and "Lessinia", 94%, in particular) have the tendency not to keep machines (but in many cases the farm site is nearby), however, those in "Sette Comuni", "Grappa" and "Alto Astico e Posina" are behaving in the opposite way (65%, 42%, 55% are keeping machines, respectively). As regards SP facilities, drinking water for more than 25% of its (131 SP over 485) is unavailable (the shortage is concentrated in particular in "Lessinia" and "Prealpi Trevigiane" mountain communities, where half of SP is this situation, data not discussed in tables), again about 25% has no electricity power lines and a small percentage of SP dispose of electricity generators (slightly 10%, Table 1) but almost none have alternative energy sources. Finally, over 10% of SP (with no particular geographic concentrations) does not have housing for staff (54 SP over 485). These scarcities in logistic features, equipment and facilities, often reflect a different use of the SP (in some cases when used as a daily commuting), but in other cases are real inconvenience for the personnel. Concerning the services offered by the SP, in particular agritourisms and restaurant, we noted that agritourisms are rarely present, being only a 17% of the units surveyed (Table 1). Among the mountain communities, this activity is especially well spread and developed in "Agordina" (35%), "Grappa" (42%), although to a lesser extent, in "Treviso" (27%). On the contrary, it is very uncommon in "Lessinia", "Baldo", "Sette Comuni", and "Alto Astico e Posina" mountain communities (1%, 5%, 14%, and 1%, respectively).

The reasons for these differences are numerous. Tourist flow and (infra) structural SP conditions are important to know and to consider, but not only. In some mountain communities (Sette Comuni for example), which also presents very accessible and well equipped SP (as described above), the agritouristic activities has not so far been encouraged by the mountain community, who preferred to invest in breeding facilities, milk processing and pasture management, which are the traditional and typical activities of SP (*Berni and Fabbris, 1983; Ziliotto et al., 2004; Pasut et al., 2006; Koroschitz et al., 2009*). For that, a negligible percentage of SP is empowered to offer accommodation to tourists and hikers (4%; 19 SP over 485). Summer pastures with agritourisms have begun to show good farm specialization activity and the tendency to farm business improvement (*Berni and Fabbris, 1983; Pasut et al., 2006; Venerus et al., 2007*). In fact, there are very few SP which have an opening duration of less than 90 days (mainly as bar only; data not in table), and about one-third open holding for more than 4 months (offering bar and restaurant services; data not in table), taking advantage of weekends or holiday periods outside the summer season.

1.3 Stables, livestock units and farming

Summered Livestock Units were subdivided into 4 uniform classes, following the variability distribution of the considered variable (Table 2). Summer pastures with less than 30 LU were almost 30% of the total, those with a medium LU were almost the same (158 SP over 485 in total), however, medium-large SP (having from 60 to 90 LU on average) were only 20%, and a small number of SP have summered more than 120 LU (73 SP over 485). Regarding the number of stalls present *in situ*, more than 10% of SP do not have a stall or shelter for livestock, while the majority (almost ¾) utilizes 1 (Table 2). There are, however, particularly in "Grappa" and "Lessinia" mountain communities, SP that use 2 stables (46% and 23%, respectively). However, are very rare those SP that use 3 or even 4 barns, for this reason, and in order to simplify this aspect, SP with more than one stable were grouped, and represent 15% of the total units surveyed (Table 2). Almost all the herdsmen used barns only for milking or to house animals (in the event of particularly adverse weather conditions), but the animals typically spend the day and night free-grazing. Moreover, still in Table 2 are presented the frequencies of SP by species and category of summered livestock. Summer pastures that load lactating cows are 239 (50% of the total), that we preferred to classify into 3 equal intervals, and we observed that the majority of SP that keep dairy cows *in situ* during the summering period are mainly those who have small to medium herd sizes (less than 30 cows; 102 SP over 239 in total; and from 30 to 60 cows; 94 SP over 239).

Table 2. Active livestock structural and productive variables used in the analysis (part1)

Variable	Classes	*N*
*Summered LU[1]		
LU (s)	<30	142
LU (m)	30 - 60	158
LU (ml)	60 - 90	102
LU (l)	>120	73
Stalls		
Stalls no	0	52
Stalls min	1	360
Stalls max	>1	73
Dairy cattle present		
DAIRY yes	Yes	239
DAIRY no	No	246
Dairy cows (LU)		
DAIRY (s)	<30	102
DAIRY (m)	30 - 60	94
DAIRY (l)	>60	43
Dry/Replacement cows present		
D-R yes	Yes	348
D-R no	No	137
Dry/Replacement Cows (LU)		
D-R (s)	<30	251
D-R (m)	30 - 60	68
D-R (l)	>60	29
Beef cattle present (BEEF) [2]		
BEEF yes	Yes	65
BEEF no	No	420
Suckling cows present (SUC) [3]		
SUC yes	Yes	34
SUC no	No	451
Sheep present (SH) [4]		
SH yes	Yes	61
SH no	No	424
Horses present (HO) [2]		
HO yes	Yes	40
HO no	No	445
Pig present (PIG)		
PIG yes	Yes	97
PIG no	No	388

N: number of summer pastures surveyed.
LU: Livestock Unit.
(s): small; (m): medium; (l): large.
[1]: in the same summer pasture may be summered various animal species/categories.
[2]: considered only when summering more than 5 units.
[3]: considered only when summering more than 3 units.
[4]: considered only when summering more than 10 units.
* missing data occurred.

Table 3. Active livestock structural and productive variables used in the analysis (part2)

Variable	Classes	*N*
Supplementation with concentrate (CONC)		
When DAIRY CONC yes	Yes	150
When DAIRY CONC no	No	37
When Other[1] CONC yes	Yes	20
When Other[1] CONC no	No	73
Milking parlour		
Milking parlour yes	Yes	70
Milking parlour no	No	170
Milk production (kg/d)		148
Milk production (l)	<8	24
Milk production (ml)	8 - 12	49
Milk production (m)	12 - 16	39
Milk production (mh)	16 - 20	21
Milk production (h)	>20	15
Refrigeration tank (REF)		
REF yes	Yes	156
REF no	No	83
Cheese making (CHEESE)		
CHEESE yes	Yes	117
CHEESE no	No	368

[1]: Other: refers to other bovine categories (not DAIRY).
(l): low; (ml): medium low; (m): medium; (mh): medium high; (h): high.
(s): small; (ms): medium small; (m): medium; (ml): medium large; (l): large.

Summer pastures with dry/replacement cows (including heifers) are 348 (a bit more than 70% of the total) and are mainly of small herds (less than 30 LU; over 70% of the D-R cows present, see Table 2 for details). However, SP with dairy cows only count 41, and they are 148 those loading only dry/replacement cows (results not shown in table). Both “Lessinia” and “Sette Comuni” mountain communities enclose about 20% of SP that are loaded exclusively with dairy cattle.

Regarding the other livestock categories and species (Beef “BEEF”, suckling cows “SUC”, sheep “SH”, horses “HO” and pigs “PIG”), no particular trends were observed and few SP have performed another typology of farming (Table 2). In fact, SP units that load fattening cattle on pasture (beef cattle or heifers) are 13% of the total (emphasizing that they have been excluded those with less than 6 animals) and among the mountain communities, the frequency with which we encounter this category is significant in "Brenta" (20%). Fewer (7% of the total) are the suckling cows' SP (still, in this case, SP with less than 3 heads were excluded). Sheep and/or goats (at least 10 heads) are found in 13% of the SP, and horses (at least 5 heads) only in 8%. However, pigs are found in 20% of SP. This frequency is equal to more than 80% of the units that process milk into cheese (Table 3), confirming the traditional link between the activity of milk processing and the use of cheese production residue to feed the pigs (*Sturaro et al., 2009*).

Regarding the feed supplementation, we choose to divide the categorical variable studied CONC (see Table 3) into 2 main categories DAIRY and Other (each category is divided again into 2 sub-categories). Almost 80% of DAIRY summer pasture units (with lactating cows) carried a dietary supplementation (with concentrates) at pasture during the summer period (Table 3), thus compensating for the pasture production scarcity (*Marini et al., 2008; Mrad et al., 2009a*) and pasture lower nutritive value (*Bovolenta et al., 2008*). The situation is reversed if we consider the SP that summered other classes of cattle or other species: in this case almost 80% never do any feed supplementation at pasture.

In milk producing SP, almost 30% of its has a milking parlour (Table 3). The remaining SP used mainly the pipeline milking system, the hand milking or bucket milking devices. Among the different mountain communities, 70% of SP in "Sette Comuni" dispose of a milking parlour, but only 17% in "Lessinia" (data not reported in table). Concerning milk production, and for over half of SP with lactating cows (148 SP over 239 dairy SP in total; see also Table 2), we were able to obtain an estimate of productivity, when the respondent has proved to be sufficiently competent and willing to provide the information. The results are shown in Table 3, where milk production (kg/d) was classified into 5 homogeneous classes, after considering the variability distribution of the variable studied. Summer pastures that do not reach 8 kg/head/d are almost 20% of total SP, those with productions between 8 and 12 kg/head/d are 30%, those producing 12-16 kg/head/d are 25%, those with 16-20 kg/head/d are 15%, and finally, 10% of SP rose to more than 20 kg/head/d. Comparing the mountain communities, "Lessinia" SP seem to be dairy-vocated (80% of SP producing between 12 and 20 kg/head/d), but especially the "Sette Comuni" mountain community, where almost 1/3 of SP produces more than 20kg/head/d (data not in table). In the other mountain communities, however, the level of production tends to concentrate on classes of less than 12 kg/head/d (data not reported in table). As regards milk processing facilities, we found that over 65% of the bovine milk-producing units are equipped with bath cooling milk or refrigeration tanks (156 SP over a total of 239 dairy SP). Even in this case is remarkable, of course, the frequency with which this allocation is present in the alpine pastures of "Sette Comuni" (80% of SP) and "Lessinia" (75%;

data to be detailed later on). However, when we consider the SP engaged in milk processing (only 25% of the SP sample, see Table 3), the situation is rather different among the mountain communities as the cheese making is prevalent in almost all of them except for "Baldo" (27%, data not in table) and "Lessinia" (5%, data not in table). Summer pasture on site cheese-making is closely tied to the direct sale of products (*Berni and Fabbris, 1983; Ziliotto et al., 2004; Pasut et al., 2006; Koroschitz et al., 2009)*, although in some cases it was found as one might also purchase products not directly worked *in situ*.

1.4 Pasture management

In order to simplify the analysis, pasture area of each SP unit was subdivided into 5 equal classes, based on the variability distribution of the numerical variable considered, going from the smallest one (pasture area under 25 ha), to the highest one (pasture surface above 100 ha). The results presented in Table 4 shows that summer pastures have generally small to medium-small surfaces (almost 50% of SP dispose of grazing area <25 ha and between 25 and 50 ha). The medium, medium-large and large pasture areas, respectively between 50 to 75 ha, between 75 to 100 ha, and above 100 ha, are generally distributed the same, almost 15% of SP in each class (28 pasture surfaces corresponding to 28 SP are missing data). Our SP sample has proved to belong to mountain grazing pastures of small to medium areas, we expect therefore, a medium-high to high stocking rates. In fact, stocking rate (STOCK) expressed in LU/ha was classified into 5 equal groups, and we noted that the highest number of SP are those having STOCK between 0,75 and 1 LU/ha and > 1,25 LU/ha (109 SP and 107 SP over 451; respectively; 34 SP as missing data; Table 4). However, despite the higher stocking rate that proved to have almost half of SP, this rate seems not to be excessive (*Ohlenbusch and Watson, 1994*), demonstrating the high feed supply through the use of concentrates during the grazing season to compensate for the pasture productivity (*Ziliotto et al., 2004; Giupponi et al., 2006; Pasut et al., 2006; Bovolenta et al., 2008; Koroschitz et al., 2009*). Perhaps, it was surprising that there are SP units that produce milk, relying only on the pasture biomass production. The quantities of milk produced through the use of forage only are relatively low and never exceeded 12 kg/head/day.

Regarding the SP weed encroachment, the estimated weed coverage "WEED" shows that about 60% of the examined sections of pasture are still in a good condition (coverage below 10%), but also that about 25% of SP shows significant signs of degradation (sections with weed coverage of 20 to 30% and > 30%). Weed mowing is hence not very practiced by SP herdsmen, also due to the harsh climatic and topographic conditions of the alpine pastures (*Giupponi et al., 2006; Marini et al., 2008*), leading to a sub-optimal utilization of alpine pasture resources and an increase of weed encroachment and shrubs-woodland colonization (*Mrad et al., 2009a*).

Table 4. Active pasture characteristics used in the analysis (part3)

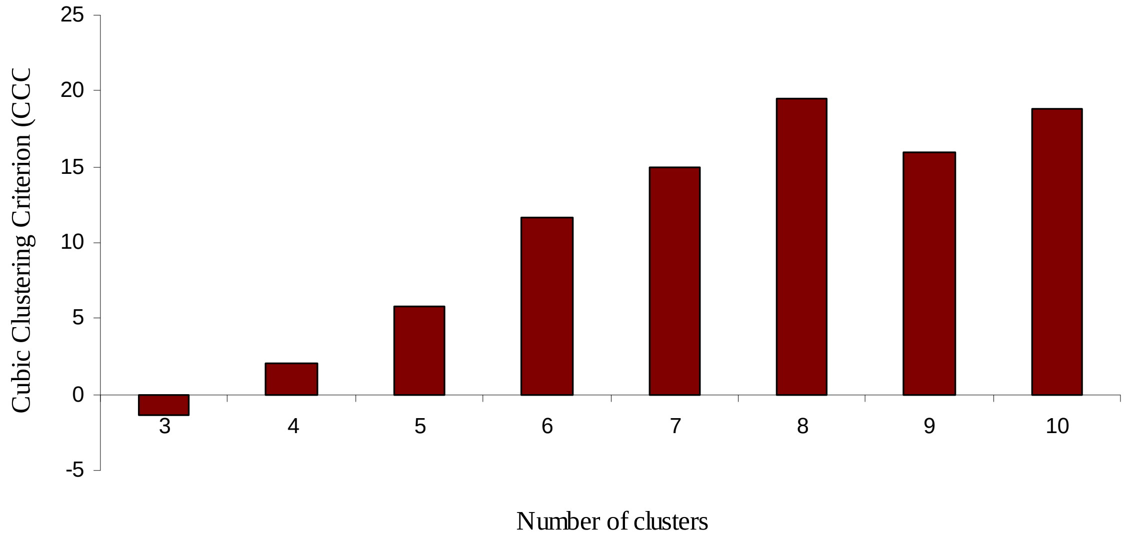
Variable	Classes	*N*
Pasture area (PASTURE) [1] (ha)		457
PASTURE (s) [2]	<25	114
PASTURE (ms)	25 - 50	115
PASTURE (m)	50 - 75	74
PASTURE (ml)	75 - 100	64
PASTURE (l)	>100	90
Stocking rate (STOCK) (LU/ha) [3]		451
STOCK (l)	<0,5	74
STOCK (ml)	0,5 - 0,75	76
STOCK (m)	0,75 - 1	109
STOCK (mh)	1 - 1,25	85
STOCK (h)	>1,25	107
Weed encroachment (WEED) (%)		160
WEED (l)	<10	84
WEED (m)	10 - 20	36
WEED (mh)	20 - 30	22
WEED (h)	>30	18

(l): low; (ml): medium low; (m): medium; (mh): medium high; (h): high.
(s): small; (ms): medium small; (m): medium; (ml): medium large; (l): large.
[1]: Classes were determined on the basis of the released subsidies. Below 50 ha of pasture area (mountainous zones), summer pasture units are given a maximum quota of 250 € /ha (a 20% of reduction is applicable on the additional 25 ha when pastures surface are of 75 ha). Above the 75 ha allowed, there is no more subsidies given.
[2]: the old regulation had established that no summer pastures could exist if its pasture area is under 10 ha, however, 30 units (of 457 total) have a pasture area of or lower than 10 ha. Their sustainability seems to be at risk.
[3]: Classes were determined following the regulation established by the Veneto Region in the mountain areas. A minimum of 0,5 LU/ha should be present in order to be eligible for the subsidy.

2. Identification of homogeneous clusters: Multivariate analysis

The cluster analysis was carried out from 3 to 10 clusters and maximisation of CCC was obtained with 8 clusters (Figure 3). The root mean square (RMS) of standard deviations, which measures the degree of dispersion within each cluster, ranged from 0,299 to 0,391 (Table 5). Some overlapping between clusters can be deduced by comparing the maximum distance between a seed and the observations of its cluster, with the distance between the two centroids of two close clusters (*Nargundkar and Ozler, 1998; McGarigal et al., 2000; Usai et al., 2006).*

Figure 3. Cubic clustering criterion according to the number of clusters.



After a screening of the clusters identified, we choose to group the cluster 5 and 7 in a unique cluster because they both demonstrate to have very similar characteristics (Tables 6 and 7). The 484 retained SP units (one SP unit was eliminated from the cluster analysis) were grouped as shown in Table 6 and in Figure 4. In case of missing data for some variables, the analysis assigned the SP to the closest cluster on the basis of the available information (*Nargundkar and Ozler, 1998; McGarigal et al., 2000*).

Table 5. Main statistics of the cluster analysis.

Cluster	Number of farms	RMS[a] of S.D.	Max distance seed-observation	Nearest cluster	Distance between cluster centroids
1	70	0,331	2,306	4	1,293
2	83	0,315	2,303	4	1,551
3	24	0,365	2,453	1	3,019
4	147	0,299	2,489	1	1,293
5	67	0,350	2,792	7	1,440
6	13	0,408	2,883	2	2,682
7	70	0,355	2,676	5	1,440
8	10	0,391	2,664	7	2,747

[a]: Root Mean Square.

2.1 Cluster analysis: profiles of the identified groups

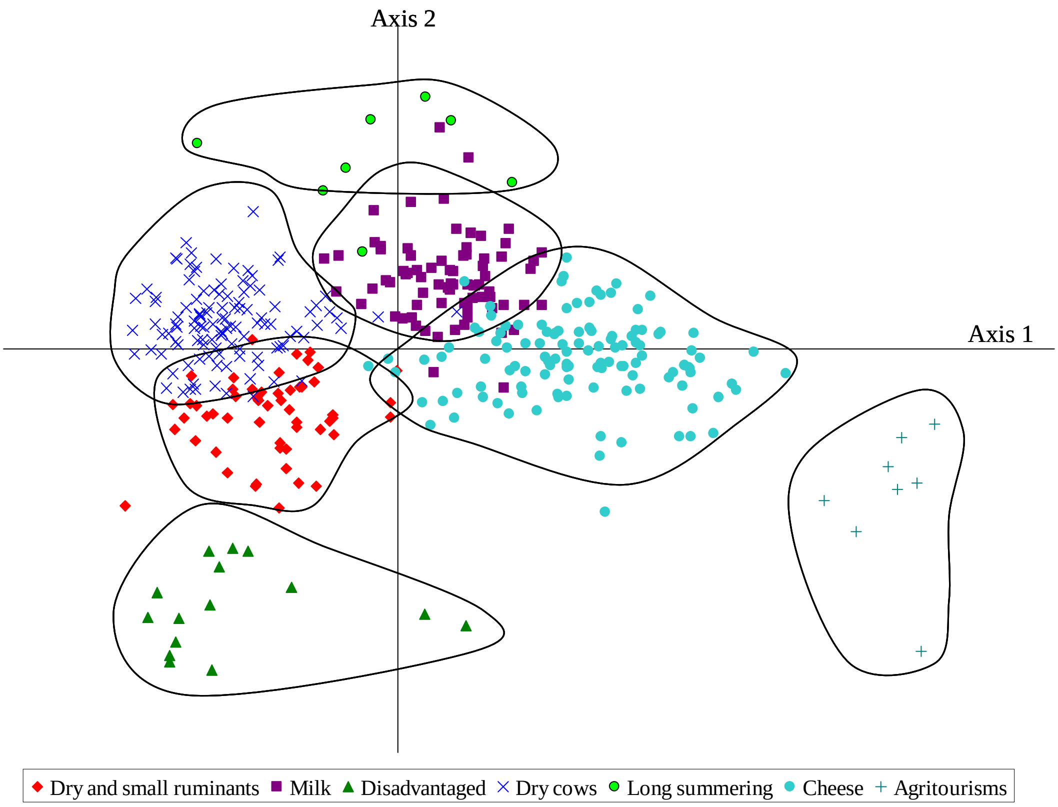
Table 7 shows descriptive statistics of original variables with reference to the database as a whole, considering the variables retained significant for the multivariate analysis (mean values are reported as the percentage of SP for each retained cluster).

The different SP typologies identified are characterized by:

- SP of "*dry cows and small ruminants*": the first cluster includes 70 alpine summer pastures (Table 6). Units are mostly of public ownership, difficult to reach or in some parts with no accessible roads, used to summer dry cows (34%) and small ruminants (48%). Dairy cows farming (only 6%), and therefore the milking equipment and the cheese making activity are practically absent (Table 7). The average summering period length is a bit more than 3 months and a half, the workforce is minimal, even if more than 80% of farmers are living *in situ* during the summering period.
- SP of dairy cows, without milk processing, called "*Milk*" SP: this second cluster consists of a group of 83 alpine units, 53 of which are belonging to privates (Table 6). Generally, they are accessible by car, moreover, staff housing is available but very often not used. In fact, only 40% of herdsmen live in the SP house during the summering. Besides, dairy cows and replacement cows are reared in these SP, and the production is almost always sold to dairies or external cheese factories, in fact, only 13 units produce on-farm cheese (Table 6). In this group, the availability of electricity power lines is generally good, as well as for potable water. The mean summering period is of 124 days (Table 7).
- "*Disadvantaged*" SP: are 24 units grouped into one category because of a number of characteristics that make them less favourable than the others. First, animals are summered for very short periods with an average of 44 ± 15 days (Table 7). The road system is deficient for several SP units, with 6 of them that can be reached only on foot (Table 6). The availability of housing, watering and electricity is often lacking, for these reasons, only 9 over 24 herdsmen are residing in loco. They are units with dry cattle or small ruminants, in some cases short-term used by transhumant herders.
- "*Dry cows*": the fourth cluster is the largest with 147 units. Holdings are mostly of private ownership, quite easily reachable, used to summer dry/replacement cows. Completely absent are the recreational or marketing activities. The average length of summering period is equal to 4 months, and the workforce is minimal, with less than 20% of herdsmen living *in situ* (Table 7).

- SP summered with dairy cattle where milk is processed into cheese for direct sales: called "*Cheese*". This is a group of 137 SP, mostly publicly owned, characterized by favourable structural features. The accessibility is excellent (129 over 137 SP are reachable with normal car, see table 6), almost all have potable water, housing and electricity. This means that most SP conductors are residing throughout the summering period (118 over 137), with a fair proportion of SP offering bar and restaurant services (24% and 36%, respectively; Table 7). The stocking rate is made up of 60% from dairy cows and 30% of replacement cows, with 69% of the SP that directly processes the milk into cheese (94 over 137; Table 6). Milking is done mainly with bucket or milking parlour, and the workforce is on average equal to 3,6 employees. The average period of summering corresponds to the habitual 4 months, usually from early June to late September. In the preliminary analysis (data not in table), these SP were divided into two groups that varied only for the type of electricity available: 54 SP supplied by electricity power line formed a separate category from those supplied by generators or alternative sources of energy. It seemed logical to group them into a single cluster, but it should be noted that the electricity power line connection is a major benefit for those who need to milk and refrigerate the daily milk produced (*Polelli, 1974; Berni and Fabbris, 1983; Pasut et al., 2006; Koroschitz et al., 2009*).
- Alpine pastures with a "*long summering*" period: This is a group of 13 SP, mostly privately owned, easily accessible by normal car, where the summering period is particularly long, on average of 176 days ± 18 days (Table 7). These SP are loaded primarily with dry cows (54%) and small ruminants (30%), which can be raised on pasture for long periods without special care, particularly at lower elevations (*Castel et al., 2003; Usai et al., 2006*).
- "*Agritourisms*": This small cluster consisting of only 10 SP include units where the workforce is very numerous (7,7 ± 0,9 people), and when the agritouristic activity is often the primary employment. Indeed, 9 over 10 of these units have the restaurant and 4 ensure the availability of accommodation for tourists (Table 6). In these SP, livestock are mainly dairy cows, and production is almost entirely processed for sale and consumption in agritourism (*Pasut et al., 2006; Venerus et al., 2007; Cocca, 2008; García-Martínez et al., 2008; Koroschitz et al., 2009; Mrad et al., 2009b*). All the herdsmen live *in situ*, and are all provided with potable water and electricity (Table 7). Therefore, these are SP in which farming is only functional to the needs of the agritourism and sometimes considered to be marginal compared to the agritouristic activities.

Figure 4. Cluster analysis: Farming systems distribution.



2.2 Geographic distribution of the identified clusters

The distribution of typologies within the sub-areas was tested with the $\chi 2$ test. From the geographical point of view, the seven clusters identified have a heterogeneous distribution within the territory (Table 8). Given the low number of summer pastures in certain mountain communities, we decided to group the smaller ones on the basis of their geographical proximity/closeness (Figure 3). The mountain communities of "Baldo", "Lessinia" and "Sette Comuni", for which was available a large number of SP, remained independent. The other areas were made up as follows:

- North Belluno: Comelico Sappada, Centro Cadore, Val del Boite and Agordina.
- South Belluno: Longaronese-Cadore-Zoldano, Alpago, Belluno-Ponte, Valbelluna and Feltrina.
- Treviso: Grappa and Prealpi Trevigiane.
- Vicenza: Agno Chiampo, Alto Astico e Posina, dall'Astico al Brenta, Leogra Timonchio and Brenta.

Table 6. Number of SP allocated by cluster.

N. of SP	Cluster 1 Dry & Small ruminants	Cluster 2 Milk	Cluster 3 Disadvantaged	Cluster 4 Dry cows	Cluster 5 Cheese	Cluster 6 Long summering	Cluster 7 Agritourisms
Public ownership	59	30	11	44	94	2	8
Private ownership	11	53	13	103	43	11	2
Accessible by normal car	46	79	15	124	129	12	9
Accessible on foot	13	2	6	5	4	0	0
Resident *in situ*	58	33	8	27	118	8	10
Watering	55	62	15	80	124	6	10
Electricity power line	16	60	6	40	54	4	6
Electricity generators	19	21	4	32	74	5	3
Alternative energy	14	1	4	9	22	2	2
Available housing	62	77	16	121	134	10	9
Bar	0	3	0	1	33	3	3
Restaurant	0	1	1	2	50	1	9
Accommodation for tourists	0	0	1	1	10	2	4
Hand milking	2	1	0	4	5	0	0
Pipeline milking	0	19	0	3	18	0	0
Milking parlour	1	23	1	5	40	0	6
Bucket milking	2	37	2	4	49	4	4
Refrigeration tank	1	75	1	0	70	2	7
Cheese making	3	13	1	2	94	4	9
Cows in milk	6	80	3	17	114	2	8
Dry/Replacem. cows	26	27	14	117	54	9	5
Beef cattle	5	0	1	14	4	2	0
Small ruminants	35	0	6	4	9	4	0
Total SP	**70**	**83**	**24**	**147**	**137**	**13**	**10**

SP: summer pasture.

Table 7. Profiles of the identified clusters: mean values* of variables studied. Data are given as proportion of summer units in the cluster, unless otherwise indicated.

Variable	**Cluster 1**	**Cluster 2**	**Cluster 3**	**Cluster 4**	**Cluster 5**	**Cluster 6**	**Cluster 7**
N. of SP	70	83	24	147	137	13	10
Public ownership	0,84	0,36	0,46	0,30	0,69	0,15	0,80
Private ownership	0,16	0,64	0,54	0,70	0,31	0,85	0,20
Accessible by normal car	0,67	0,95	0,63	0,84	0,94	0,92	0,90
Accessible on foot	0,19	0,02	0,25	0,03	0,03	0,00	0,00
Elevation (m a.s.l.; mean ± SD)	1535 ± 273	1317± 204	1401 ± 339	1375 ± 250	1461± 241	1298 ± 254	1410 ± 244
Summering (days; mean ± SD)	109 ± 12	124 ± 9	44 ± 15	120 ± 11	117 ± 12	176 ± 18	108 ± 21
Manpower (mean ± SD)	1,9 ± 0,7	2,0 ± 0,6	1,5 ± 0,6	1,4 ± 0,6	3,6 ± 0,9	2,2 ± 1,2	7,7 ± 0,9
Resident *in situ*	0,85	0,40	0,38	0,18	0,86	0,62	1,00
Watering	0,80	0,75	0,65	0,54	0,91	0,46	1,00
Electricity power line	0,24	0,72	0,25	0,27	0,40	0,31	0,60
Electricity generators	0,28	0,25	0,17	0,22	0,54	0,38	0,33
Alternative energy	0,20	0,01	0,17	0,06	0,16	0,15	0,20
Available housing	0,89	0,93	0,67	0,82	0,98	0,77	0,90
Bar	0,00	0,04	0,00	0,01	0,24	0,23	0,30
Restaurant	0,00	0,01	0,04	0,01	0,36	0,08	0,90
Accommodation for tourists	0,00	0,00	0,04	0,01	0,07	0,15	0,40
Hand Milking	0,03	0,01	0,00	0,03	0,04	0,00	0,00
Pipeline Milking	0,00	0,23	0,00	0,02	0,14	0,00	0,00
Milking Parlour	0,02	0,28	0,05	0,04	0,31	0,00	0,60
Bucket milking	0,03	0,45	0,09	0,03	0,37	0,31	0,40
Refrigeration tank	0,01	0,90	0,05	0,00	0,53	0,15	0,70
Cheese making	0,04	0,16	0,04	0,01	0,69	0,31	0,90
Cows on milk (% of LU/unit)	0,06	0,73	0,09	0,08	0,60	0,10	0,61
Dry/replacem. cows (% of LU/unit)	0,34	0,25	0,54	0,79	0,29	0,54	0,37
Beef cattle (% of LU/unit)	0,08	0,03	0,03	0,08	0,04	0,07	0,02
Small ruminants (% of LU/unit)	0,48	0,00	0,25	0,03	0,06	0,30	0,01
Definition	**Dry & Small ruminants**	**Milk**	**Disadvantaged**	**Dry cows**	**Cheese**	**Long summering**	**Agritourisms**

* For each variable, the percentage of SP of each cluster is reported. Eg: the value 0,84 referred to the variable "Public ownership" in the cluster 1 indicates that public SP represent 84% of the given cluster. Summering days and Total manpower are expressed as mean and SD.

Figure 3. Study area subdivision into sub areas.

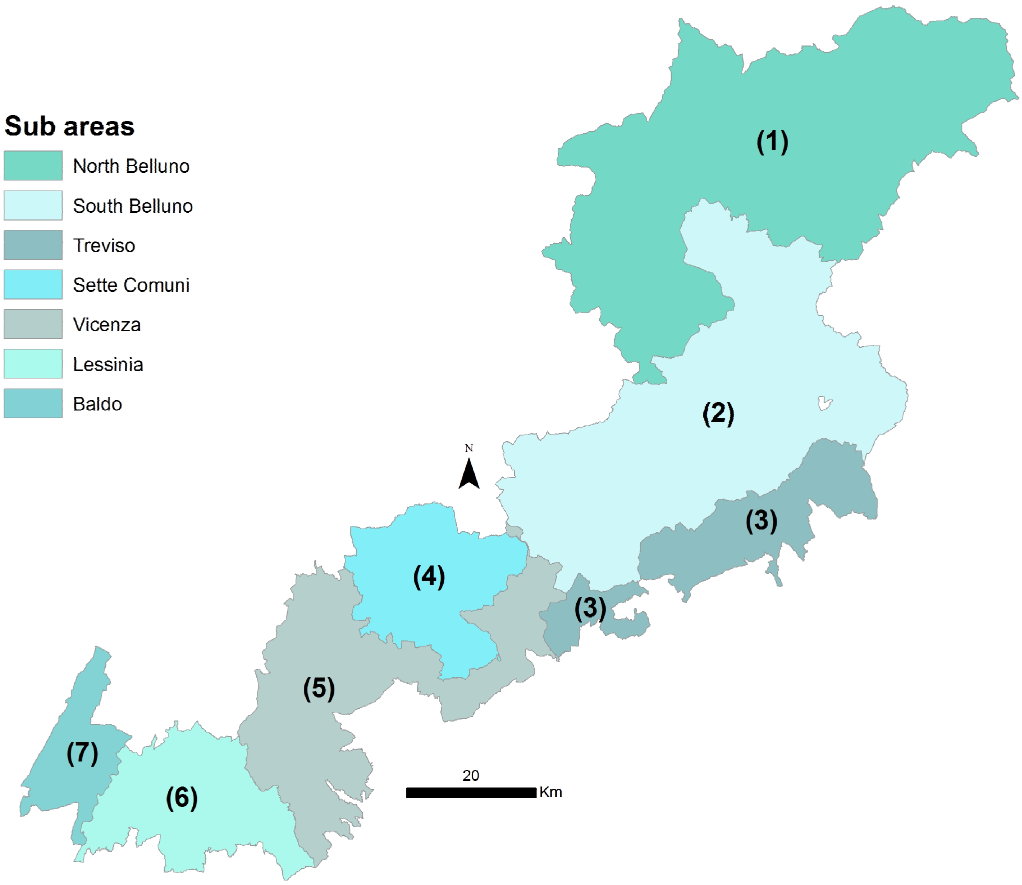


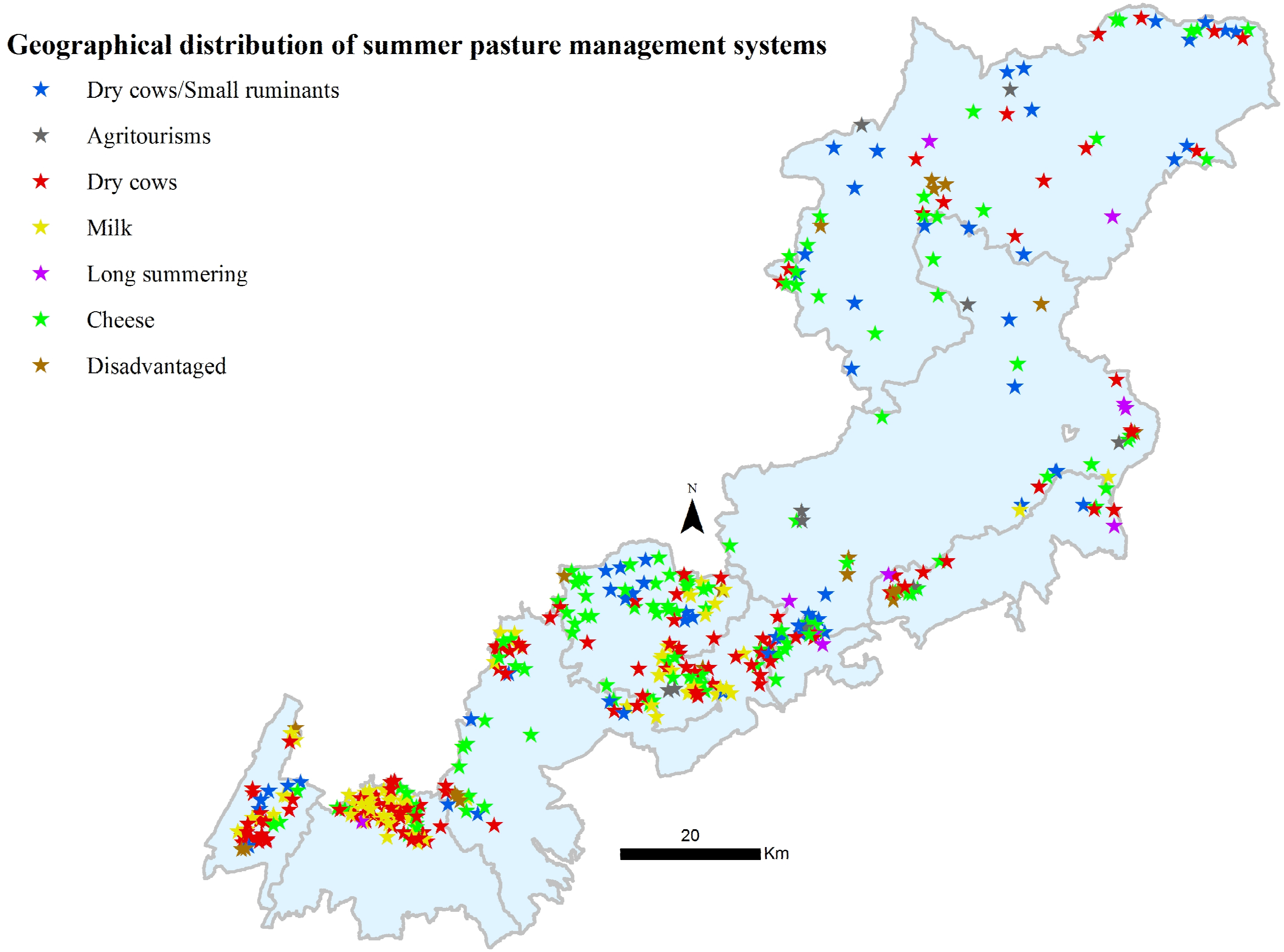
Table 8. Summer pasture partition by sub-area among clusters.

Sub area	Dry & Small ruminants	Milk	Disadvantaged	Dry cows	Cheese	Long summering	Agritourisms	Tot
Baldo	6	9	3	20	3	0	0	41
Belluno nord	21	1	5	18	27	1	2	75
Belluno sud	11	2	4	6	14	3	4	44
Lessinia	1	35	0	36	14	1	0	87
Sette comuni	15	17	2	13	42	0	2	91
Treviso	4	1	4	19	18	7	2	55
Vicenza	12	18	6	35	19	1	0	91
Total	**70**	**83**	**24**	**147**	**137**	**13**	**10**	**484**

The distribution of SP management systems within the sub-areas showed a link between the territory and the clusters (χ^2 = 178,9, df = 42, P <0,001). In particular, we can consider as an example two sub-areas: "Lessinia" and "Sette Comuni". The first one is characterized by a large number of SP included in cluster 2 "*Milk*", i.e. SP with dairy cows without cheese making. Important is the number of SP in the cluster 4 (*dry cows*) while there are very few SP belonging to the other groups. "Lessinia" differs from the other groups because is composed for almost all of private SP, which summered dairy cattle or replacement cows of farmers who remain living *in situ* during the summering period and climb to the pasture only for milking or to control the herd (*Ziliotto et al., 2004; Pasut et al., 2006; Venerus et al., 2007; Marini et al., 2008*).

However, in the "Sette Comuni" mountain community, most of the SP are included in cluster 5 "*Cheese*", characterized by a summering of dairy cows with on-farm cheese processing. The guidelines established by the mountain communities have in fact encouraged the spread of this management system (*Ziliotto et al., 2004; Pasut et al., 2006; Venerus et al., 2007)*, and the results from the statistical analysis confirm this trend (Table 6, 7 and 8). For a better understanding of the geographical distribution of the clusters identified, refer to Figure 4, where different colours correspond to different clusters.

Figure 4. Geographical distribution of summer pasture management systems amongst the study area.



3. Synthetic evaluation and convenience/inconvenience indexes of SP management

The objective of this part was to plan for each SP unit a synthetic index that allows to quantify the management convenience/ inconvenience and benefits generated from farming in order to implement a system for the evaluation of some economic measures to sustain the alpine pastures of the Veneto region.

Summer pastures perform functions that go beyond the production of commercial goods, contributing to the diversification of the recreational value of the mountainous areas, particularly for visitors and tourists (*Hunziker, 1995; Giupponi et al., 2006*), as well as biodiversity and cultural heritage conservation (*Del Favero et al., 2000; Baudry and Thenail, 2004; Kristensen et al., 2004; Gibon, 2005; Pasut et al., 2006*). For that, the provision of government subsidies aiming at paying for positive externalities produced by summer pastures is an essential tool to shift from market failures and to improve the collective welfare. The areas that would be loaded in the absence of government subsidies would be below those that are considered optimal in terms of community needs. Obviously, since SP are able to produce both commercial benefits, properly rewarded by the market, and non-commercial ones, they must be paid through a system of public subsidies that needs to be efficient from an economic standpoint. In other words, the remuneration of the positive externalities produced by the SP unit should be commensurate with the magnitude of external benefits that it is capable of producing (*Thiene et al., 2008*). Although we have methods for monetary evaluation of external benefits of agro-pastoral and forestry activities, the effective limits of these methods suggest that the most correct way to improve the effectiveness and efficiency in the payment of public subsidies is to be provided with approaches related to multicriteria analysis (*Lebart et al., 1995; Legendre and Legendre, 1998; Pasut et al., 2006, Thiene et al., 2006*). With these methods we first identify the functions that are considered important for public intervention, then we identify possible indicators of these functions for each of the entities involved in the public intervention. Finally, a specific weight is assigned to each indicator in order to achieve the identification of a synthetic indicator which enables to quantify the importance of each economic unit with respect to the functions we want to evaluate. The method has the advantage of being sufficiently transparent and to assess the effect of alternative weighting schemes (*weights*) on the funding provision for the various economic units involved. It should be noted that the weighting scheme should be a choice of public policy-makers and should be determined *a priori*, possibly consulting neutral experts. A clarification must be made with reference to the indicators used to quantify the various functions. Some may be objective and easily available (for example: the accessibility, the type of livestock reared, the on-farm product retail, etc…see Table 9) while for others (the touristic frequency, the quantity of products sold, etc…), we have much more limited information. In these cases, it would be desirable in future to proceed with periodic monitoring.

3.1 Evaluation index structure

The evaluation index was developed in two steps:

1. Initially, a sample of 346 SP was chosen, and an index was defined, which we called "complex index" (Table 9). This first tool takes into account all the variables of interest, although some of them are hard to update for a routine use of the index, so it is very detailed and complete.
2. Subsequently, a second index was developed, which takes into account only variables that can be easily updated and verified, called "simplified index" (Table 10). This second tool is obviously less articulated and analytical, but still includes descriptive variables for all major functions performed by the summer pastures. It has the considerable advantage of being applied to all SP that dispose of only a part of information and could therefore be a tool to be used in future for the annual ranking of SP units. The efficacy of the simplified index was tested using a simple statistical comparison based on the evaluation variation produced by each individual unit respect to those produced with the complex index.

The structure and composition of the two indexes are described as following:

3.1.1 The Complex index (CI)

The index is calculated as the sum of a series of specific indicators, to assess a number of situations of convenience/inconvenience and/or potentially different functions performed by the SP unit, according to the following general formula:

$$\mathbf{CI = WLI + WEII + WSI + WRI + WEI}$$

Where:

WLI: Weighted Livestock index
WII: Weighted Environmental Inconvenience Index
WSI: Weighted Social index
WRI: Weighted Recreational index
WEI: Weighted Environmental index

The composition of the individual specific index and the assignment of specific weights are detailed in Table 9.

Table 9. Specific indexes, parameters, factors and weights used for the calculation of the complex index.

Specific index	Parameters	Factors	Values assigned to factors	Weights assigned to	
				Parameter	Index
Livestock	Predominant animal category	Beef cattle	0,1	0,7	0,4
		Small ruminants	0,2		
		Dry/ Replacement cows	0,3		
		Cows in milk	1		
	Resident *in situ*	Yes	1	0,3	
		No	0		
Environmental inconvenience	Accessibility	Normal car	0,25	0,33	0,3
		SUV	0,5		
		four wheel tractors	0,75		
		On foot	1		
	Altitude		Values standardized on 90^{th} percentile (1)	0,33	
	Pasture	A = % of pasture with an altitude between 0-10%	1	0,33	
		B = % of pasture with an altitude between 10-30%	2		
		C = % of pasture with an altitude >30%	4		
		Total pasture	(A*1) + (B*2) + (C*4) standardized on 90^{th} percentile		
Social	Manpower (farming)	Summering period * number of employees in farming (2)	Values standardized on 90^{th} percentile	0,5	0,1
	Manpower (no farming)	Agritourism Opening days * number of employees not in farming (3)	Values standardized on 90^{th} percentile	0,5	
Recreational	Recreational events	TP = Touristic presence (tourist/ha).	TP*0,5 if TP<40 (90^{th} percentile) TP*0,25 if TP<=40		0,1
		DE = Daily events (daily/ha)			
		Recreational events = TP + DE	Values standardized on 90^{th} percentile		
	Summer pasture attractiveness:	B = Bar yes/no	1/0	0,1	
		R = Restaurant (n. of covers)	Values standardized on 90^{th} percentile	0,3	
		A = Accommodation (n. of beds)	Values standardized on 90^{th} percentile	0,3	
		M = Marketing (cheese) Yes/No	1/0	0,3	
		Total attractiveness = B + R + A + M	Standardized to the maximum value		
	Final recreational index = recreational events * summer pasture attractiveness				
Environmental	Summer pasture belonging to a SCI/SPA areas (4): yes/no		1/0	1	0,1

(1): The following example clarifies how the data are standardized to 90^{th} percentile. For the altitude, 90% of the summer pastures have an elevation of less than 1743 m a. s. l. For all the structures situated above 1743 m was assigned a score of 0.33 (i.e. the maximum possible based on the weight assigned to the parameter), while the other score was given according to the ratio of their altitude and the threshold of 1743. For example, a summer pasture at 1500 m will have a score of 1500/1743 * 0,33 = 0,28. This will limit the impact that might have the summer pastures of "extreme" altitude, which could flatten too much the differences between all the other structures.

(2): farmer, dairyman, shepherd.

(3): waiter, cook, cheese-maker.

(4): SCI: Sites of Community Importance; SPA: Special Protection Area.

3.1.1.1 Livestock index (LI)

Livestock index consists of the sum of the value assigned to the parameter "category of summered livestock" and the value assigned to the parameter "resident *in situ* during summer" (Table 9). The first parameter aims to reward the maintenance of traditional dairy cattle farming in the Veneto region (as evident from the values assigned to each category, see Table 9), while the second awards the SP units in which the herdsman is permanently resident *in situ* during the summering period, assuming that the permanent presence of the herdsmen/conductor guarantees a better care of pastures and structures.

3.1.1.2 Environmental Inconvenience Index

This index is intended to compensate the SP units that are disadvantaged from an environmental point of view, and in which, therefore, the management is made difficult or inconvenient. It is calculated as the sum of the values assigned to the parameters "accessibility", "pasture altitude" and "pasture slope" (Table 9). Considering the "accessibility", SP units rewarded are those accessible by less comfortable means of transport, so the units reachable on foot obtain the maximum value and those reached in a normal car, the minimum. Regarding the "altitude", the more the SP unit is of high elevation site, the more it gets the incentive, assuming that, in case of high elevation pastures, the productivity is low (*Marini et al., 2008*), the summering season is short, and is more difficult to summer high value livestock categories. In this case, the value was not assigned on the basis of elevation classes, but has been normalized to the value of 90^{th} percentile, in order to reduce the weight that may have individual structures located at very high altitudes. Regarding the "slope", are rewarded SP units operating at high declination pastures, and therefore have difficulty summering the more productive livestock categories (*Marini et al., 2008; Mrad et al., 2009a*). The value is calculated first by dividing the pasture area into three slope classes, and then obtaining the weighted average of its values (Table 9). Each of these parameters (accessibility, altitude, slope) has an equal importance, and so counts for 33% in the calculation of the environmental inconvenience index. A hypothetical SP unit at high altitude, reachable only by foot and with a pasture slope > 30% will therefore have an environmental inconvenience index of 1.

3.1.1.3 Social Index

The Social Index is conceived to reward those SP units that provide more job opportunities. It consists of the sum of the value of two parameters, one that takes into account the activities closely related to animal husbandry, and one that considers those associated with agritourism services or dairy product retail:

- Total working days of strictly farming activities. The score is calculated as the product of total farming workers (herdsman, milkman, shepherd) and the summering days, where farming personnel are the herdsmen, milkmen and shepherds. The obtained value is then normalized at its 90th percentile.
- Total working days of specialized workers involved in activities related to agritourism or restaurant services. The score is calculated as the product of the total employees working in agritourism (cook, waiter, handyman, cheese-maker, other) and the agritourism opening days. The obtained value is then normalized at its 90th percentile.

Both parameters have the same weight (0,5) for the final index value.

3.1.1.4 Recreational Index

The recreational index derived from the consideration of the parameter called "recreational events" which assesses the touristic-recreational level of the area where the SP holding is located, and partly, also, the "SP attractiveness" which assesses its ability to attract tourists (from an aesthetic point of view). Here to be well noted that, unlike the previous specific indexes, the values of the two parameters are not added but multiplied. The recreational events are based on the assumption that the environmental services provided by a SP unit are related to the territory use by the mountain area' visitors. SP holdings that are located close to highly frequented areas should be more supported than others which are located in mountainous areas but where the recreational phenomenon is not widespread (*Thiene, 2005; Thiene et al., 2005, 2006, 2007*). The recreational events were estimated as the sum of the values of the parameters "Presence of tourist" and "daily events" (Table 9). The first parameter, which estimate the tourists staying in mountain villages, was obtained from the detailed data at the municipal level provided by the Veneto Region, firstly aggregated by the mountain communities and, subsequently, in relation with the mountain sub-areas defined before (*see section 2, figure 3*). The day's events deal with daily visitors, performing one day trip, for which there is practically no source of information or statistical survey unit. Therefore, estimates of the daily visitors flow were used (*Tempesta, 2004; Tempesta and Thiene, 2004*). The final value of the parameter has been normalized respect to the maximum and minimum threshold values. Regarding the degree of SP attractiveness, the capacity of the summer pasture unit to provide agritouristic/restaurant services was considered at various levels. In fact, some services were found to be minimal like some dairy products retail (cheese, butter, ricotta cheese), but some others not, like intensive agritouristic activities that provide bar and restaurant services, but also the structure availability for overnight stay. The value of each of these factors, calculated and weighed differently as explained in Table 9, was added to obtain the final value of SP attractiveness, which was then standardized to 90th percentile.

3.1.1.5 Environmental index

Summer pastures can also play a key conservation action of grassland habitat, valuable from a natural and landscape point of view (*Del Favero et al., 2000; MacDonald et al., 2000; Giupponi et al., 2006; Gellrich et al., 2007; Tasser et al., 2007*). Accurate assessment of these aspects would require the availability of a mapping for all pasture types belonging to SP units. This aspect should be considered, and it was decided to reward SP that are located into SCI/SPA areas thanks to the environmental role they play and/or will be carried out (Table 9).

3.1.1.6 The overall complex index calculation

The overall index is the sum of the final specific indexes described above, appropriately weighted according to the weights given in Table 9. It has been decided in this calculation to give the priority to farming (LI) (with a weight of 0,4) and to environmental inconvenience (with a weight of 0,3), the social, recreational and environmental components were not excluded, but were considered less relevant for the purposes of implementing the overall index, receiving a weight equal to 0,1 each. With these weights, are then rewarded the SP in which there are dairy cows, managed by a resident herdsman, located in disadvantaged areas, difficult to reach, with harsh topographic conditions of slope and elevation. Further, more limited incentives are allocated according to the social (job offers), tourism, recreational and environmental SP role. To better understand the practical application of the index, in Table A1 (*see Appendix II*) an example based on real data of the surveyed SP units is proposed.

3.1.2 Simplified Index

In order to have a tool for practical use, it was then developed a simplified index, with the same basis as the complex one but that can be calculated from available data (through an on-farm survey) and thus easily updated and checked. This index was applied for the same sample of SP units that we used to calculate the complex one (346 SP), in order to assess the response obtained with the simplified approach than the analytical/complex one (Table 10). Compared to the complex index, in the calculation of the simplified one, no social index was considered which requires information on the SP manpower. It was considered appropriate not to treat it as such information can be gathered only on the basis of self-certifications difficult to test, and less objective. The weights assigned for the livestock and environmental inconvenience indexes have not changed, while the recreational and environmental indexes have been more assessed (0,15 each).

Table 10. Specific indexes, parameters, factors and weights used for the calculation of the simplified (basic) index.

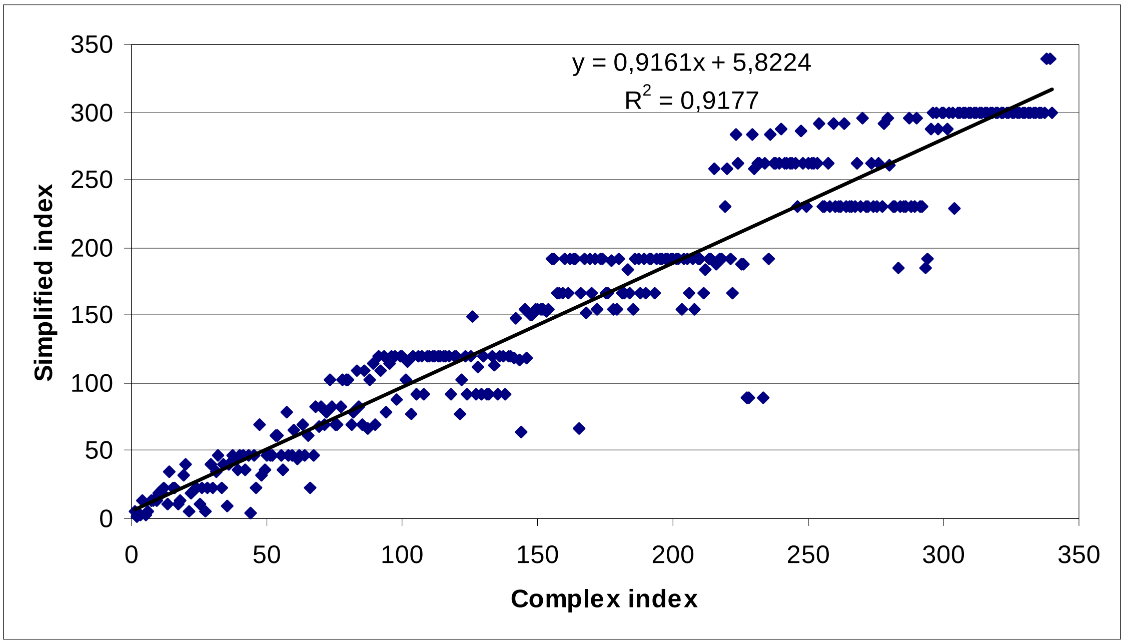
Specific index	Parameters	Factors	Values assigned to factors	Weights assigned to	
				Parameter	Index
Livestock	Predominant animal category	Beef cattle	0,1	0,7	0,4
		Small ruminants	0,2		
		Dry/ Replacement cows	0,3		
		Cows in milk	1		
	Resident *in situ*	Yes	1	0,3	
		No	0		
Environmental inconvenience	Accessibility	Normal car	0,25	1	0,3
		SUV	0,5		
		four wheel tractors	0,75		
		On foot	1		
Recreational	Recreational events	TP = Touristic presence (tourist/ha)	TP*0,5 if TP<40 (90^{th} percentile) TP*0,25 if TP<=40		0,15
		DE = Daily events (daily/ha)			
		Recreational events = TP + DE	Standardized on 90^{th} percentile		
	Summer pasture attractivenes s:	B = Bar yes/no	1/0	0,1	
		R = Restaurant (n. of covers)	1/0	0,3	
		A = Accommodation (n. of beds)	1/0	0,3	
		M = Marketing (cheese) Yes/No	1/0	0,3	
		Total attractiveness = B + R + A + M	Standardized to the maximum value		
	Final recreational index = recreational events * summer pasture attractiveness				
Environmental	Summer pasture belonging to a SCI/SPA areas [(1)]: yes/no		1/0	1	0,15

[(1)]: SCI: Sites of Community Importance; SPA: Special Protection Area.

An example of calculation of the simplified index, considering the same SP unit used in the calculation of the complex one, is shown in Table A2 (see *Appendix II*). The total value of the final simplified index is lower than that obtained with the complex one, but this does not affect the classification of the SP unit.

To test the reliability of the simplified index, a comparison between the results obtained with the complex index and those obtained with the simplified one was conducted. Summer pastures were ordered according to the complex index, from the highest to the lowest value. The ranks obtained were correlated with those calculated using the simplified index, and the results are shown in Figure 5. The correlation between the two indexes is close to 100%, confirming the validity of the simplified index. The only SP units for which the assessment changes substantially are those accessible only on foot: in fact, the simplified index favours more these types of SP than the complex one (which also considers the altitude and slope in the inconvenience index), meeting the need to reward more the disadvantaged SP. Given that the simplified index is based on many categorical variables, some SP themselves assume the same final index value, and thus are classified as equal in the ranks calculation. The simplified index, developed and validated on 346 SP for which information was fully available, can be applied to the entire sample of SP surveyed (485 SP in total, *see section 1*). Given the effectiveness of the simplified index, it is possible to give a simplified synthetic assessment of all SP units using only a part of the information available.

Figure 5. Correlation between the ranks of the complex index versus the simplified index. The numbers on the axes indicate the ranking of the SP units, in descending order.



Using the simplified index, it will be possible to have a practical and easy to update instrument that could be used to target more specifically the economic aid and the political support for the mountain farming, and in particular to the conservation and maintenance of mountain open areas. It is in fact an easily obtainable data at the early application stage for the incentives, through the establishment of appropriate application forms. It has also the advantage of being calibrated and updated at any time, by changing the weights assigned to individual sub-indexes of interest.

The arrangements for allocating values of the individual factors and the calculation and standardization procedures of individual parameters and specific indexes always lead to values between 1 and fraction units (between 0 and 1). By varying the relative values of the factors and weights assigned to the individual parameters and to specific indexes, we can change also, if it is retained necessary, the weight given to the various functions performed by a SP unit and its evaluation index (of convenience/Inconvenience). It can therefore not to be considered as a final result, but as a working tool that can be gradually improved and adapted to specific or local needs.

4. Analysis of pastures status in relation with slope, elevation, stocking rate and weed encroachment

Pastures contour belonging to each SP unit was digitised in GIS, based on orthophotos and Regional Technical maps. Pasture areas were then calculated. Elevation and slope were then determined by means of Digital Elevation Model 10 x 10 m resolution (ArcGIS 9.2 ®). Pasture slope was classified into 3 classes and a slope index was build considering the disadvantage that a SP could have when belonging to very steep areas. Pastures of less than 10% slope were given a slope index of 1, those between 10 % and 30% were attributed a slope index of 2, however, those belonging to areas of more than 30% were given a slope index equal to 4.

We wanted to study the relationships that might exist between the convenience/Inconvenience economic index (simplified) developed above (*section 3*), and slope index, as well as pasture area, elevation and stocking rate. Correlations between the listed variables were calculated (Table 11). We did not found any significant relationship between the economic index and the slope index, demonstrating that these two indexes are completely independent and that slope did not influenced the economic convenience or inconvenience of summer pastures. The same result was found for elevation, when compared to the economic index.

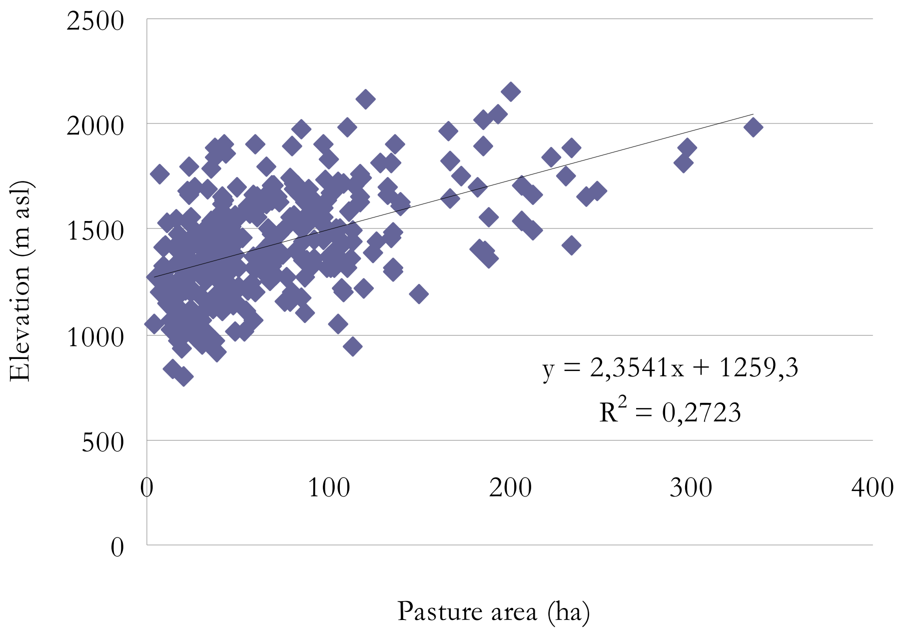
However, we found positive, even low, correlations between the slope index, pasture area, and elevation (Table 11). Pastures of high elevation are those where the slope index is high, and pasture area in these parts is important due to the inconvenient topographic conditions. As a consequence, the correlation between stocking rate and slope index was significant, even low, and negative, proving that at the increase of slope, there is a small decrease of livestock density. However, positive relationships were found between elevation and pasture area (Figure 6). Pastures of very high elevation are inaccessible (*Marini et al., 2008; Mrad et al., 2009a*) and thus large pasture areas are at risk of abandonment (*MacDonald et al., 2000*). A negative correlation, consequently, was found between stocking rate, pasture surface and elevation (Figure 6). At the increase of elevation, stocking rate slightly decreases (R^2 = 0,096), also because livestock prefer generally to graze on gentle and accessible areas (*Marini et al., 2008; Mrad et al., 2009a*).

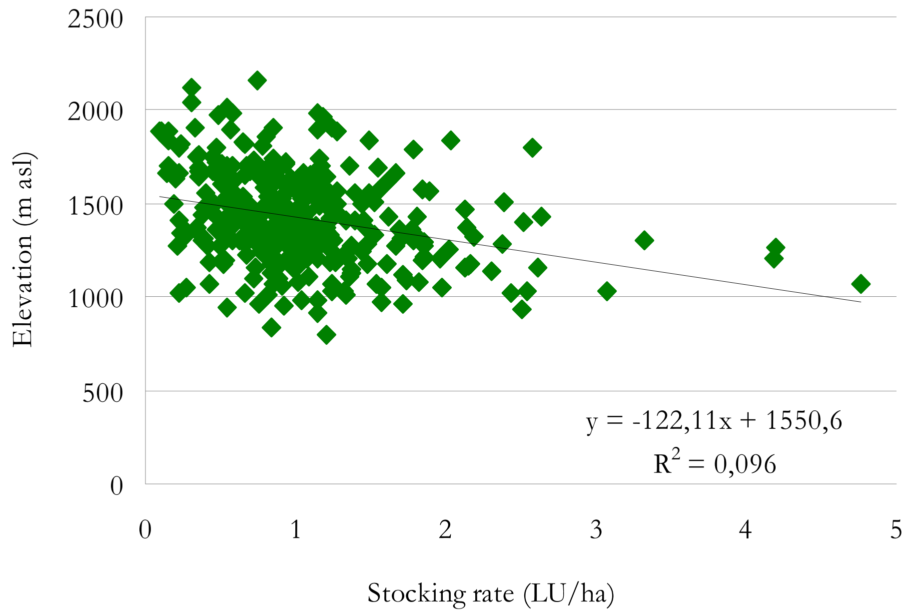
Table 11. Correlations between SP economic index and various pasture characteristics

	Slope Index	Elevation	Stocking rate	Pasture area
Convenience/Inconvenience Index	-0,036	0,040	0,026	0,051
Slope Index	1	0,165**	-0,126*	0,207***
Elevation		1	-0,302***	0,517***
Stocking rate			1	-0,499***

* P<0,05; ** P<0,01; *** P<0,001.

Figure 6. Correlations between pasture elevation, pasture area and stocking rate





When considering dairy cows on pasture, we have found that stocking rate of such category of animals have been slightly reduced when elevation increases (R^2=0,16; P<0,01), however, this trend was not significant for dry cows (R^2=0,04; NS), as they seem not to be influenced by the increase of elevation values. Regarding pasture weed encroachment, a classification was made considering low the level of encroachment if less than 10%, moderate if between 10% to 20% or 20% to 30%, and high if above 30%. A sample of 209 SP was considered for this analysis (the available data for this analysis was little and sometimes not accurate). We did not found any relationship between weed encroachment rate and the economic index, showing that weed encroachment level did not affected the economic convenience or inconvenience of summer pastures. A recent study about weed encroachment and stocking rate was conducted considering a small sample of summer pastures belonging to Lessinia mountain community (*Mrad et al., 2009a, Chapter 3/a*) suggested to consider this aspect for an optimal pasture management.

Conclusions

Summer pastures of the Veneto region showed a remarkable subdivision into seven different management systems. The traditional summering of milking cows remains in almost 50% of the sampled units, but with at least 3 different groups represented by “Cheese”, “Agritourisms” and “Milk” systems.

The first group comprises holdings where direct processing of milk and marketing of cheese increase revenues, with the addition of bar/restaurant service in few cases. Moreover, traditional farm-made cheeses are produced directly *in situ* and are mainly destined to domestic consumption or small local markets (*Pasut et al., 2006; Usai et al., 2006*).

The second, small group of holdings has been able to develop the agro-touristic offer into a major economic activity (*Pasut et al., 2006; Koroschitz et al., 2009*). Both these groups have easy accessibility, good facilities, and appear to be economically viable.

Holdings of the third group are mostly private owned and managed as an appendix of the permanent farm, where the milk produced is taken daily to be sold. The viability of these holdings depends on the continuation of farming by the owner.

The remaining 50% of alpine summer pastures, represented by “Dry & Small ruminants”, “Disadvantaged”, “Dry cows” and “Long summering” systems, has generally poor facilities (*Castel et al., 2002; Usai et al., 2006*) and hold mainly dry/replacement cows and small ruminants, with a small sub group characterised by a very short summering period (the disadvantaged SP) and another small group holding dry cows for very long summering period (the long summering SP). These are the holdings whose viability appears more at risk.

The different groups identified throughout the study showed also a clear tendency to concentrate spatially in different portions of the study area and so depend on the continuation of farming by the owner.

The multivariate approach used in this research study, thus, allowed us to detect the large differences that exist in the livestock management systems of the Veneto region. This will help us to envisage different scenarios with different development pathways.

Therefore, the importance of summer pastures from a structural and economic point of view was clearly demonstrated in the first part of the study. Moreover, in the second part, we tried to develop a synthetic method through the building of economic indicators to assess the sustainability of the summer pastures but also to better define the strategies of implementation of such systems when necessary. Summer pastures, thus, have demonstrated to be of a great importance from a touristic and a recreational point of view, rather important for the alpine territory conservation (*Thiene, 2005; Thiene et al., 2005; Pasut et al., 2006; Thiene et al., 2007; Venerus et al., 2007*), when contributing to the diversification of the recreational value of the mountainous areas, particularly for that vast group of visitors/tourists interested in visiting paths of high altitude (*Hunziker, 1995*).

From an environmental point of view, the alpine summer pastures have expressed their contribution to the conservation and the maintenance of open areas that often correspond to habitat of community value and interest, providing food and shelter to many animal species (*Benvenuti et al., 2002; Baudry and Thenail, 2004; Ziliotto et al., 2004; Giupponi et al., 2006*). It is so with no doubt that summer pastures favour the maintenance of biodiversity in mountain areas.

Regarding the topographic aspects of pastures, no surprising results were found as at the increase of slope and elevation, stocking rate decreases. However, summer pasture' stocking rate never goes above 1,1 LU/ha on average, except for small ruminant SP where we found values of about 1,3 LU/ha, due to the small pasture areas, sometimes of less than 10 ha, dedicated to large small ruminant flocks, generally located in marginalised and less accessible areas, which has increased a bit the mean stocking rate.

In conclusion, policies and development strategies aiming to sustain the alpine summer pastures of the Veneto region must take into account the variability of management systems and their geographical distribution as well as the economic indicators developed on the basis of each particular case, for more targeted and efficient actions as well as a more adequate management of the summer pasture resources and a better characterisation and traceability of the traditional summer pasture products.

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Chapter 4

THE ALPINE SUMMER PASTURES IN THE VENETO REGION: ANALYSIS OF *FARMING STYLES*

Abstract

Alpine summer pastures (SP) are traditional and very old livestock production systems that are considered very important for the ongoing of the mountain farming. Farmers, when managing their farms, are behaving differently as regard the decisions that one could take to conduct his agribusiness, and that is a *farming style*. The essential defining characteristic of a set of styles is that they explain the diversity in agriculture in a specific region and they explain why traditional farming practices continues to survive. The aim of this study was to study the diversity in styles of farming in Veneto region, north-eastern Italy, and to evaluate the behaviour of summer pasture conductors regarding their management techniques as well as their future perspectives. A sample of 169 SP managers was considered and a on-farm questionnaire was conducted in order to collect behavioural and attitudinal information regarding SP management and future prospects. A non-Hierarchical cluster analysis was performed and four main *farming styles* were identified: 1- *Young traditionalist*; 2- *Mature traditionalist*; 3- *Young businessman*; 4- *Mature businessman*. SP conductors of the Veneto region have proved to behave differently as regards management activities, having different opinions and perspectives vis-à-vis their future. *Farming styles* were distributed heterogeneously amongst the study area, indicating a strong link between the farmer behaviour and the territory. Public institutions and regional policies should consider the different styles that could exist among a region or a given farming system, as well as their geographical distribution, for a better sustaining of the traditional mountain farming.

Keywords: Farming styles, Summer pastures, farmer behaviour, mountain farming.

Riassunto

Le malghe sono dei sistemi di produzione tradizionali e molto vecchi che sono considerati molto importanti per il mantenimento dell'agricoltura di montagna. Gli agricoltori, nella gestione delle loro aziende, si comportano in modo diverso per quanto riguarda le decisioni che si possono adottare per gestire le loro attività, questi sono gli stili aziendali. La caratteristica essenziale che definisce un insieme di stili è che spiegano la diversità in agricoltura in una specifica regione e perché le pratiche agricole tradizionali riescano a sopravvivere. L'obiettivo di questo studio era di studiare la diversità degli stili aziendali nella regione Veneto e valutare il comportamento dei conduttori delle malghe per quanto riguarda le tecniche di gestione, nonché le loro prospettive future. Un campione di 169 malghesi è stato considerato e un questionario con visita in malga è stata condotta al fine di raccogliere informazioni comportamentali e attitudinali del malghese riguardando la gestione delle malghe. Una cluster analysis non gerarchica è stata effettuata e quattro stili aziendali sono stati individuati: 1- *Tradizionalista giovane*; 2- *Tradizionalista maturo*, 3- *Imprenditore giovane*; 4- *Imprenditore maturo*. I conduttori delle malghe della regione Veneto hanno dimostrato di comportarsi in modo diverso per quanto riguarda le attività di gestione, che hanno opinioni diverse così come le loro prospettive future. Gli stili di gestione sono stati distribuiti in un modo eterogeneo sul territorio, indicando un forte legame tra il comportamento del malghese e il territorio. Le istituzioni pubbliche e le politiche regionali dovrebbero considerare i diversi stili che potrebbero esistere all'interno della regione oppure dei sistemi di allevamento, nonché la loro distribuzione geografica, per un sostegno dell'intera filiera zootecnica montana tradizionale.

Parole Chiavi: Stili di gestione, malghe, comportamento del malghese, montagna.

Introduction

Alpine pasturing is the expression of a balanced interaction between human activity and natural environment; it represents an important economic resource for the local mountain community and guaranties the conservation of mountain resources and natural biodiversity (*Gibon, 2005; Giupponi et al., 2006*). A better knowledge of the available resources and ecological functionalities of alpine pastures is necessary for a future sustainable conservation and development of those areas (*Mrad et al., 2009a,b; Chapter 3 and 3/a*). In this framework, we wanted also to study not only the farm but also the farmer, through his attitudes, behaviours and motivations towards farming. Farming is a social activity about which there is much myth-making, and stories or parables about farmers abound in farming discourse (*Vanclay et al., 2006*).

Styles of farming or farming styles is a theoretical approach for understanding diversity in farming communities and was originally developed by Jan Douwe van der Ploeg at Wageningen University, The Netherlands in the late 1980s and early 1990s (*van der Ploeg, 1993; van der Ploeg, 1994; van der Ploeg and Long, 1994*). Other researches using the concept of farming styles have been undertaken in Australia (*Vanclay and Lawrence, 1994; Howden et al., 1998; Thomson, 2001; Vanclay et al., 2006*), and in Europe (*Bertolina, 1974; Beedell and Rehman, 1999; Commandeur et al., 2007*).

Many definitions were given to this revolutionary concept. The farming style' pioneer preferred to define it as "…a concrete form of praxis, a particular unity of thinking and doing, of theory and practice…" or also as "…a way in which one has to organise and manage a farm that is generally accepted by a more or less connected group of farmers…" (*van der Ploeg, 1993; van der Ploeg, 1994; van der Ploeg and Long, 1994*). Another Australian researcher has introduce it as "…a set of strategic notions, values and insights shared by a particular group of farmers concerning the way farming ought to be organised…" (*Vanclay and Lawrence, 1994; Vanclay et al., 2006*). Others have define it as "…a specific structuring of the practice of farming that corresponds to the strategic notions or cultural repertoire used by these farmers" or also as "…a specific set of interlinkages between the farm enterprise on the one hand and the surrounding markets, market agencies, government policy and technological developments on the other…" (*Howden et al., 1998; Thomson, 2001*).

The essence of the concept of farming styles is that in a farming community there is a set of discrete styles (strategies of farming) of which farmers are actually aware and from which they actually choose a specific strategy to guide their own practice because it provides a framework to explain the observations that people dealing with farmers make on the basis of qualitative research and personal experience (*Vanclay et al., 2006; Commandeur et al., 2007*).

Each style is multidimensional, they are the attributes of a region, commodity, farm, and of the farmer, depending of the level of style (*van der Ploeg, 1993; Vanclay and Lawrence, 1994; Vanclay et al., 2006*). Styles are created not only through socio-cultural dynamics but also as a response to structural forces, and different styles exist for different market situations of different farmers (*Willock et al., 1999; Vanclay et al., 2006, Commandeur et al., 2007*). Hence, farming styles theory promises to provide the agricultural science and extension workers with a better model for understanding adoption farmer behaviour and the multitude of management strategies utilised by farmers and the rationalisation of these strategies (*Bertolina, 1974; van der Ploeg and Long, 1994; Howden et al., 1998; Willock et al., 1999; Slee et al., 2006; Commandeur et al., 2007*).

Different styles of farming were identified in every branch of farming, even within more or less homogeneous regions. Previous studies, as reported in Chapter 2, have shown that livestock farming in Belluno province, NE Italy, was divided into five different traditional farming styles. Moreover, *Commandeur et al. (2007)* in a recent study in French Brittany, have identified five styles of intensive swine farming, *Schmitzberger et al. (2005)*, eight styles of farming amongst Austrian farmers, and four different environmental-enhancing farming styles in UK *(Willock et al., 1999; Slee et al., 2006).*

In the alpine part of the Veneto region, the traditional livestock farming is still sustainable despite the climatic and topographic difficulties (*Giupponi et al., 2006; Marini et al., 2008; Mrad et al., 2009a*) as well as infrastructural and agronomic reasons (*Cocca, 2008; Mrad et al., 2009b; Sturaro et al., 2009*). Previous studies have identified the different farming systems that exist in the alpine part of the Veneto region and different strategies of sustain were proposed for a better conservation of open areas, landscape conservation and farmer economic sustainability (*Sturaro et al., 2005; Cocca, 2008; Mrad et al., 2009a,b; Sturaro et al., 2009; see Chapter 3 for details*). However, a study regarding the farming styles that might exist in a whole alpine area could result useful to determine the mountain farmers needs as well as their motivations as regard mountain farming practices, helping the decision-makers to better define the aid strategies.

Objectives

This study was conducted to understand and represent stylised portraits of diversity in the logics of summer pasture conductors put into their daily practices: *styles of farming*. The first objective of this study was to explore the diversity in styles of farming in Veneto region in the alpine and sub alpine pastures of the area, north-eastern Italy, then we wanted to describe the conduct and analysis of the logic of SP managers/conductors perceptions: why do they manage their farm in a given way and how do they try and find opportunities for creating a future perspective? The second objective was to describe how the different farming styles identified are distributed amongst the territory and within the different summer pasture' farming systems identified in Chapter 3.

Material and Methods

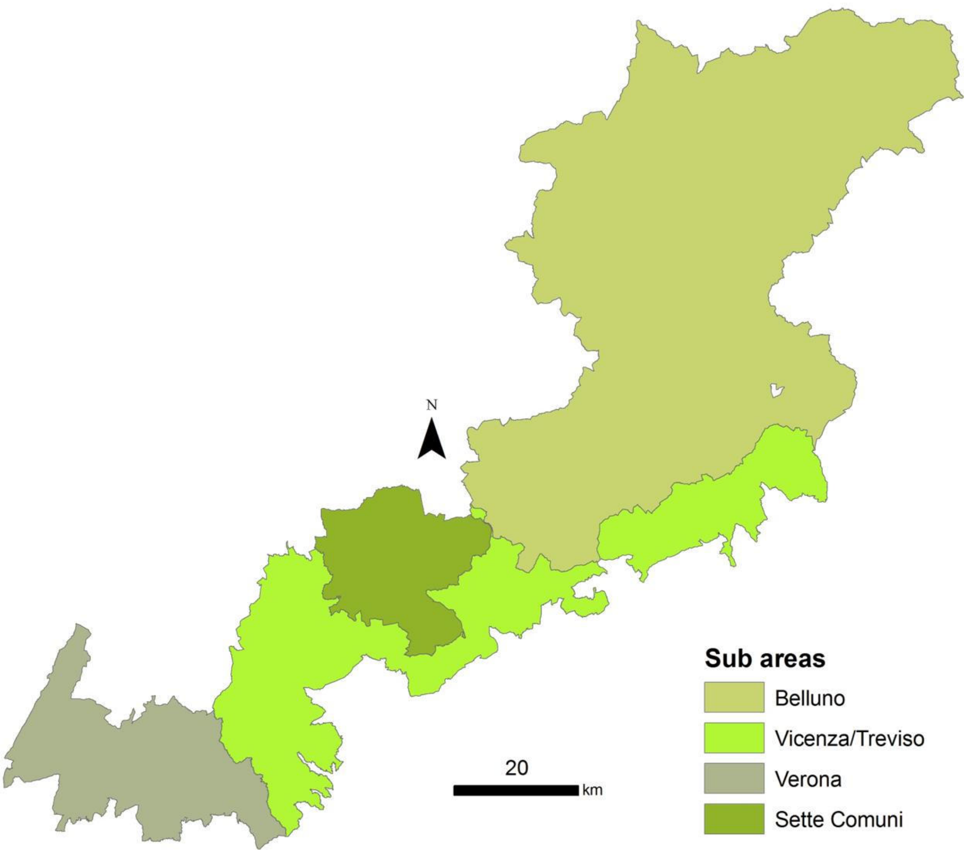
A survey concerning the adoption of *farming styles* was developed and tested using suggested survey guidelines (*van der Ploeg, 1993; van der Ploeg and Long, 1994*). Data collection for the survey took place during summer 2008 between May and September when surveying SP units for their structural and productive characteristics (*Chapter 3*). In fact, a part of the survey concerning the SP conductor attitudes and behaviour towards SP activities was done in concomitance together with that regarding SP structures, equipment and production features. A structured questionnaire was composed containing questions and set of different options of responses presented as classification variables, aiming at sorting the answer of SP conductors, depending on their level of satisfaction/dissatisfaction regarding SP farming activities. In fact, the survey included questions related to the attitudes and behaviour of farmers/SP conductors and was conducted directly on-farm to 485 conductors (gathering data regarding all 485 SP conductors for the evaluation of their motivations and preferences was impossible at this stage of the study, and so we were able to collect accurate data of only 169 SP conductors, *see Table 2*). At the end of the survey period, any ambiguous or missing responses were clarified and completed through telephone conversations. All data were entered into a database. In order to simplify the analysis, the overall study area was subdivided into 4 sub areas on the basis of their geographical and administrative closeness (Figure 1).

Statistical analysis

Descriptive statistics were calculated from quantitative data (Farmer age, Summering period (days), see Table 1), whilst qualitative data were pooled as the frequency of responses (Educational level, participation to courses, training or events, interests towards landscape, farming, marketing, etc…, see Table 1 and Table 2). In this case, some variables were classified according to a given score: 1-Very low; 2-Low; 3-Average; 4-High; 5-Very high (see Table 2 for details). The main attitudinal and behavioural variables considered in the analysis and related to farmers motivations and views about SP management are presented in Table 1 and 2. In a second step, a Non-Hierarchical *K-means* cluster analysis was performed (PROC FASTCLUS; SAS, 2006), the optimal number of clusters was defined (Table 3) and farming style profiles were determined (Table 5).

At the end, a χ^2 test was performed to compare between the faming styles distribution amongst the study sub-areas (Table 5, Figure 1).

Figure 1. Study area subdivision into sub areas.



Results and Discussion

1. Descriptive analysis

This part of the survey was of particular interest, because the SP management as well as their future developments depend on the structure characteristics but also on the motivations and expectations of the farmers/managers. Therefore, it is necessary to consider both of them.

Farmer considerations, motivations and behaviour regarding the farm status together with data relative to production features (breed, farming typology, size, etc..) are very important to define the "*farming style*" (*Bertolina, 1974, van der Ploeg, 1993; van der Ploeg and Long, 1994; Commandeur, 2007*), that is a summary of the ethical, cultural and economic objectives of farming and the subsequent ways in which farmers conduct their farms and run their activities (*Vanclay and Lawrence, 1994; Howden et al., 1998; Beedell and Rehman, 1999; Vanclay et al., 2006*). The farming style is not to be confused with the production system, which can be derived from various infrastructural, structural and technical indicators (*Gibon, 2005; Sturaro et al., 2005; Cocca, 2008; Sturaro et al., 2009*). Indeed, within similar production systems may exist different farming styles, since the person making choices is not the system but the breeder.

Because both qualitative and quantitative variables are important to consider in the identification of the farmer behaviour and motivation toward a farming or business activity, the age and education level of the SP conductor were retained for the analysis. Herdsmen age were classified into 3 classes, on the basis of the age variability distribution, and SP frequencies were calculated (Table 1). The average age, highly variable, indicates that the presence of young people is by no means rare, even if the majority of SP conductors demonstrated to be somewhat mature (almost 50% of SP managers are above 50 years old, and only 18% of them are just under 35 years old). With regard to educational qualifications, a high university degree is absent, around 20% declared to be in possess of a high school diploma, around 50% stated the middle school, and a final 30% are those having in possession a primary school diploma (Table 1).

Regarding the residence *in situ* during summering, we found that a balanced number of SP conductors was found to reside *in situ* during summer/ and as commuters from the high to the lowland (60% of resident versus 40% of commuters, see Table 1 for frequencies).

We integrated also in the questionnaire some questions regarding the decisions towards future summer pasture management and we asked the SP conductors if he is targeting a maintenance or expansion of his/her activities, or if he is planning to change location or even if he is forecasting a closure of his/her SP job.

Table 1. Active attitudinal and behavioural variables: Farmers status, participation in training courses and livestock exhibitions with an emphasis on different motivations for SP management.

Variable	Classes	*N*
Age (Years)*		
Age (y)	<35	28
Age (m)	35 - 50	58
Age (e)	>50	74
Educational level (EDUC)*		
Primary school (P)		46
Middle school (M)		82
High school (H)		31
Resident *in situ* during summer*		
Resident yes	Yes	101
Resident no	No	67
Decision towards future SP management*		
Closure yes	Yes	3
Closure no	No	157
Maintenance/ Expansion yes	Yes	145
Maintenance/ Expansion no	No	15
Propensity to change yes	Yes	6
Propensity to change no	No	154
Courses		
Courses yes	Yes	63
Courses no	No	106
Events/Exhibitions		
Events/Exhibitions yes	Yes	58
Events/Exhibitions no	No	111

(y): young; (m): medium; (e): elderly.
(P): Primary school; (M): middle school; (H): High school.
*: missing data occurred.

The variable considered in the analysis was presented of course to farmers as a dichotomous variable, and throughout their answers, we counted the number of "Yes" and "No" for each considered decision. We noted that people that are targeting an expansion and/or the maintenance of their business are numerous (145 over 160, missing data occurred here, the questionnaire was based on 169 SP conductors and we were able to collect information only of 160 SP, Table 1). SP managers that planned to leave the farming activity, maybe seeking for another job, are few (3 over 160 people), and those having the propensity to change, are only 6. Changing SP location is sometimes due to the harsh climatic and topographic conditions that could exist in the Alpine part of the region (*Sturaro et al., 2005; Giupponi et al., 2006; Cocca, 2008; Marini et al., 2008; Mrad et al., 2009a*).

Considering courses and exhibitions, most conductors have not participated in the last 5 years neither to training courses nor to livestock or product exhibitions (Table 1). The percentage of those who have done is very similar for both participations and is still quite good (about 40% of the sample).

Regarding the SP manager motivations and preferences, all the variables considered for the analysis were classification variables except for LA and AM (Table 2), and were determined following a score given to each class level (see Table 2 for details). In order to make the analysis more simple and self-explanatory, and due to the few SP number used at this stage, we choose to gather, for each variable, those SP having a score equal to 1 or 2 into a single class that we preferred to call "low", those having a score equal to 3 were retained as they are and nominated "medium", and finally, those having a score of 4 or 5 were summed and called "high". The mean score for each variable was then calculated. Going to the results, we found a high frequency of SP managers with low economic motivations (almost 50% of the sample), even if 20% of SP conductors presented a high economic interest in running SP activities. However, a mean score of 2,6 over 5 was attributed, slightly over the average, showing the importance of the economic aspect of SP activities. Moreover, SP conductors were asked to give their motivations regards landscaping. A very high percentage of people running a farming activity but interested in landscape maintenance were found (70%; Table 2). A score of 3,8 over 5 was given to landscaping, showing the high interest of SP conductors in preserving the landscape and the open areas. Similar results were discussed in *Chapter 3* and in some other recent studies (*Cocca, 2008; Sturaro et al., 2009*).

With no doubt, SP conductors were highly interested in livestock activities and were passionate for animals (138 people over 168; occurred one missing data due to sampling).

Table 2. Active attitudinal and behavioural variables: Expressed farmer views about the weaknesses and preferences on several assumptions to improve SP management

Variable	Classes[1]	*N*		Mean score[4]
Economic motivations (EM)				2,6
EM (l)	1+2	81		
EM (m)	3	53		
EM (h)	4+5	35		
Landscaping (LANDS)*				3,8
LANDS (l)	1+2	5		
LANDS (m)	3	43		
LANDS (h)	4+5	120		
Passion for animals (PA)*				4,2
PA (l)	1+2	2		
PA (m)	3	28		
PA (h)	4+5	138		
Passion for production and marketing				2,6
PPM (l)	1+2	89		
PPM (m)	3	17		
PPM (h)	4+5	57		
*Lack of alternatives (LA)[2]				1,7
LA yes	Yes	29		
LA no	No	129		
Stables (STAB)*		Enhancement	Investment	3,3
STAB (l)	1+2	44	21	
STAB (m)	3	25	15	
STAB (h)	4+5	84	106	
Marketing (MARK)*		Enhancement	Investment	2,9
MARK (l)	1+2	64	35	
MARK (m)	3	19	17	
MARK (h)	4+5	64	92	
Pasture (PAS)*		Enhancement	Investment	3,3
PAS (l)	1+2	31	2	
PAS (m)	3	53	32	
PAS (h)	4+5	72	114	
Tourism (TOUR)*		Enhancement	Investment	2,0
TOUR (l)	1+2	106	81	
TOUR (m)	3	5	14	
TOUR (h)	4+5	31	44	
Animals (ANIM)*		Enhancement	Investment	2,3
ANIM (l)	1+2	61	20	
ANIM (m)	3	30	49	
ANIM (h)	4+5	14	30	
*Availability to move (AM)[3]				2,8
AM yes	Yes	90		
AM no	No	71		

(l): low; (m): medium; (h): high. *: missing data occurred.

[1]: Classes were determined following the score given to each variable. The score 1 and 2 described the "low" level, the score 3 described the "medium" level, and the score 4 and 5 described the "high" level.

[2]: Farmers with very low and low LA classes (score= 1 and/or score= 2, respectively) were considered to have other alternatives regarding the ongoing of their activities, and so considered to be LA No, however, farmers with medium, high or very high LA classes (score= 3, 4 or 5, respectively) were considered not to have alternatives and so evaluated as LA Yes.

[3]: Farmers with very low and low AM classes (score= 1 and/or score= 2, respectively) were considered not to have the availability to move and leave the actual summer pasture, and so considered to be AM No. Farmers with medium, high or very high AM classes (score= 3, 4 or 5, respectively) were considered to have the availability to move and evaluated as AM Yes.

[4]: The farmer expressed his satisfaction with a score from 1 (extremely dissatisfied) to 5 (very satisfied). Data in the table are weighted averages of scores for number of summer pastures.

However, not all SP conductors were interested in marketing and product retail, and the average scoring was medium, about 2,6 over 5 (Table 2).

From this analysis, we were also able to detect those SP conductors who run their activities because of lack of alternatives (29 over 158, missing data occurred).

Regarding SP structures, in particular stables, farmers showed an enthusiasm in enhancing their stalls and to invest in structure improvement and expansion, the average score given was about 3,3 over 5, proving the desire of SP conductors to ameliorate SP structural features (Table 2). Almost the same finding was noted for pasture and marketing enhancement and the wish for investing in them, for a better improvement of the pasture quality, and also to be able in the future, to acquire the dairy market, important for the continuation of the traditional mountain farming and the traceability of their products (*Giupponi et al., 2006, Pasut et al., 2006*).

Surprisingly, regarding tourism, SP conductors did not show a high interest in developing agritourisms, only in few cases where a real agritouristic activity was already run (*see Chapter 3*). People may have the interest in diversifying their activities but are aware of being unable of sustaining both farming and extra-agricultural activities. Sometimes, SP are suffering from obsolete and inadequate structures and equipment conditions and are not sustained enough from the public institutions so that are incapable of improving their conditions, not thinking about tourism, but just trying to maintain the farming activity.

Finally, but not surprisingly, many people have clearly wished to move, mainly to find another location or change province, in order to enhance and improve their economic conditions (slightly 60% of them are available to move, Table 2).

2. Cluster analysis: Identification of farming styles

The cluster analysis was carried out from 2 to 7 clusters and maximisation of CCC was obtained with 4 clusters (CCC=5,670; data not in table). The root mean square (RMS) of standard deviations, which measures the degree of dispersion within each cluster, ranged from 0,313 to 0,383 (Table 3). Some overlapping between clusters can be deduced by comparing the maximum distance between a seed and the observations of its cluster, with the distance between the two centroids of two close clusters (*Nargundkar and Ozler, 1998; McGarigal et al., 2000*).

The analysis made possible to group the SP farming styles in 4 groups, as shown in Table 4. In case of missing data for some variables, the analysis assigned the SP to the closest cluster on the basis of the available information (*Nargundkar and Ozler, 1998; McGarigal et al., 2000*).

Table 3. Main statistics of the cluster analysis.

Cluster	Number of farmers	RMS[a] of S.D.	Max distance seed-observation	Nearest cluster	Distance between cluster centroids
1	40	0,365	2,407	3	1,511
2	53	0,382	2,067	4	1,687
3	36	0,383	1,897	1	1,511
4	40	0,313	1,769	1	1,517

[a]: Root Mean Square.
[b]: Cubic Clustering Criterion.

Table 4. Profiles of the identified clusters* for the "*farming styles*".

Variables	Cluster 1	Cluster 2	Cluster 3	Cluster 4
N. farmers	40	53	36	40
Age (mean ± SD)	40 ± 9	62 ± 8	35 ± 11	53 ± 9
Elementary school	0,00	0,84	0,03	0,03
Middle school	1,00	0,14	0,03	0,97
High school	0,00	0,02	0,94	0,00
Resident *in situ* during summer	0,28	0,60	0,58	0,90
Decision towards future SP management				
Closure	0,00	0,04	0,00	0,00
Change/ move	0,05	0,08	0,00	0,00
Maintenance/ Expansion	0,93	0,79	0,97	1,00
Courses	0,35	0,17	0,58	0,48
Exhibitions/ Events	0,18	0,19	0,42	0,68
Economic motivation	0,35	0,40	0,56	0,82
Landscaping	0,93	0,98	1,00	0,98
Passion for animals	0,98	0,98	1,00	1,00
Passion for production and marketing	0,26	0,25	0,50	0,90
Lack of alternatives	0,30	0,25	0,12	0,00
Availability to move	0,54	0,52	0,58	0,62
Definition	Young Traditionalist	Mature Traditionalist	Young businessman	Mature businessman

* For each variable, the percentage of SP conductors of each cluster is reported. Eg: the value 0,84 referred to the variable "Elementary school" in the cluster 2 indicates that SP conductors having an Elementary school level represent 84% of the given cluster. SP age are expressed as mean and SD.

In Table 4 are presented the main variables retained for the cluster analysis. We identified four clusters that correspond to four farming styles:

- The cluster 1, defined here as the young traditionalist farmer, and grouping 40 farmers, are those juvenile farmers (40 years on average), of medium education level (middle school diploma), where few of them are resident *in situ* during the summering season (28% only), using SP as a second activity, in general, but targeting a continuation of their activities and the maintenance or the expansion of their business (Table 4). Only 35% of them are interested in doing agricultural courses but few of them (less than 20%) are participating to livestock exhibitions or events. However, their economic motivation is rather modest, even if that regarding landscape and animal passion are very high (93% and 98%, respectively). However, they are not interested too much in production or transformation, they are just keeping their activities as low as possible, not searching for profit maximisation or income improvement. Some of them (30%) are rather working there only because of lack of other alternatives, and so for that and other reasons that almost 60% of them are available to move and change SP. The care that young traditionalist farmer have toward animals and landscape is by chance, because they do not want to intensify their activities or maximise their production; they are just maintaining the SP as a second job, and the income that could generate seems to be sufficient for them to maintain the activity.
- The second cluster, that we preferred to call "the mature traditionalist", the more numerous one, is that group of elderly SP conductors (62 years on average) of elementary school level, resident *in situ* during summer, who are willing to maintain their farming activities. These farmers are not interested in courses and exhibitions, but some of them are keeping the SP for an economic interest (40%). Maintenance of open areas and landscape as well as the passion for animals and breeding are high even if some of them (25%) are doing it because there are no other ways. However, and surprisingly, notwithstanding the aged farmer of this group, more than half of them are disposed to move, searching for a better location or SP holding. This last finding is worrying since the maintenance of mountain open areas, breeding activities, rural population and biodiversity seem to be at risk if traditionalist farmer decides to leave the mountain to find a better job (*Gibon, 2005; Giupponi et al., 2006, Cocca, 2008*).
- Regarding the cluster 3, that grouped 36 farmers called "Young businessmen", the situation is rather different. SP conductors belonging to this style are young (35 years old on average), of high school level, resident to a certain extent *in situ* during summer and willing the maintenance and the expansion of their activities (Table 4). They are highly interested in participating to training courses and animal exhibitions, their economic motivation is rather

high for more than 50% of them, but they are all respecting the landscape and are all passionate for animal breeding. Only half of them are interested in product transformation and in dairy product retail. They seem that they are doing summer pasturing for passion, taking care of the landscape and farming, and following courses and events, but at the same time, trying to enhance their income. However, they are also rather "opportunistic" because they are likely to change and move so as to maximise their profit.

- The last style identified and that we preferred to call the "Mature businessman", is that group of aged farmers that, compared to the other styles, seems to be the more similar to the previous one. In fact, farmers belonging to this style are targeting the expansion of their activities, having high economic interests, participating to events and courses and maintaining landscape and breeding, even if presenting their availability to move as to increase their income. In addition, they are interested in product selling and none of them is doing his business because he lacks other alternatives (Table 4). These farmers are maintaining their activities to maximise the income, but are also maintaining landscape and animals on pasture. The reason for that could also be that they are seeking, by conserving the open areas, to continue with mountain farming, expand their business, sell their products, and get the most out of income.

Similar farming styles were discussed in Chapter 2 regarding the Belluno province (*Sturaro et al., 2009*) and in other recent studies (*Cocca, 2008; Mrad et al., 2008*).

3. Farming styles distribution amongst the study area

The distribution of farming styles within the sub-areas was tested with the $\chi 2$ test. From the geographical point of view, the four *styles* identified have a heterogeneous distribution amongst the territory (Table 5). Given the low number of SP conductors in certain mountain communities, we decided to group them on the basis of their geographical proximity/closeness (Figure 1). We choose to maintain the administrative border between provinces and use it as a criteria for selecting the sub areas. An exception was done for the mountain community of "Sette Comuni", for which was available a large number of SP, and so remained independent. We decided also to gather Vicenza and Treviso provinces as SP conductors sample was insufficient to conduct the analysis considering the single province as an one.

Table 5. Geographic distribution of the identified clusters for *Farming Styles*.

Sub area	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Total
Belluno	7	6	13	3	29
Sette Comuni	12	17	9	28	66
Verona	12	16	6	1	35
Vicenza/Treviso	9	14	8	8	39
Total	40	53	36	40	169

The distribution of SP farming styles within the sub-areas showed a link between the territory and the styles ($\chi2$ =35; df = 9; P<0,001). In particular we can consider as an example the Belluno province, where rather half of farmers are belonging to the "Young businessman" style. This finding could be explained by the presence of many agritourisms in that area in particular, where summer pasture conductors combine both farming and agritouristic activities (*Sturaro et al., 2005; Giupponi et al., 2006; Cocca, 2008*). In "Sette Comuni" mountain community, however, we found that more than 40% of the sample is belonging to the so called "Mature businessman" style. In fact, in this area, SP managers are interested in diversifying their activities in order to maximise their profit through milk processing and cheese retail (*see Chapter 3*). The presence of "Young and mature traditionalist" farmers was also significant (18% and 26%, respectively). Moreover, we noted a certain homogeneous distribution of all the farming styles identified amongst Vicenza/Treviso provinces (Table 5). However, half of farmers belonging to the "mature traditionalist" style were located mainly in Verona province. In fact, in this area, only summer pastures traditionally managed have resisted to the tourism development and to the abandonment of farming and livestock breeding (*Cocca, 2008*).

In table 6, moreover, the distribution of the farming styles amongst the SP management systems identified in Chapter 3 showed that some farming styles are related to a particular type of management. Traditionalist styles are well distributed amongst various SP typologies, however, "Cheese" makers are those belonging to the "business" style (young and mature). "Traditionalist" farmers are those conducting the "Disadvantaged" SP and Agritourisms are mainly managed by businessmen. However, traditionalists continue to sustain the "milk" sector respect to businessmen who prefer to invest in processing and product retail.

Different farming styles were found and have proved to be well distributed among the study area. Summer pasture conductors behave differently as regard their management techniques and so we have to consider these differences to better define the support strategies.

Table 6. Distribution of farming styles amongst SP management systems.

MS/*FS*	Young Traditionalist	Mature Traditionalist	Young Businessman	Mature Businessman	Total
Dry & Small ruminants	7	7	3	4	21
Milk	6	13	5	1	25
Disadvantaged	3	3	0	0	6
Dry cows	12	12	9	5	38
Cheese	11	17	17	26	71
Long summering	1	0	0	2	3
Agritourisms	0	1	2	2	5
Total	40	53	36	40	169

MS: Management systems.
FS: Farming Styles

Conclusions

Each cluster, i.e. each "*way of farming*" identified in this Chapter is the outcome of the specific strategies of the actors involved.

Among the different areas of study emerge diverse trends, which probably reflects the farming reality in the alpine area of the Veneto region. However, and when defining the different clusters identified, corresponding to different styles of farming, we tried to give an insight into how farmers socially construct their management practices. The "Young traditionalist" and "Mature traditionalist" farmers are those less interested in production and product retail, having low economic motivation, but sometimes with no other alternatives to farming. They proved to maintain more the open areas and sustain the traditional milk production system. They have chose, at least a major part of them, not to abandon the area, thus, public institutions should consider this aspect and better sustain them. They are distributed all over the study area, but some trends were found, mainly in Verona province, which might be explained by the abandonment of farming practices that occurred in the last years in that area, to the favour of touristic activities development (*Cocca, 2008*). "Young businessmen", however, are those young farmers with a high education level, interested in landscaping, animal breeding, processing and marketing of SP products, and were mainly present in Belluno province, even if they showed a heterogeneous distribution amongst the study area. Not surprising but the Belluno province is well known for its agritourisms and on-farm product diversification, which permit to the summer pastures of the area to obtain an added-value on their dairy products, offering to the area and as a consequence to the farmers, a major income and a better economic situation (*Sturaro et al., 2005; Giupponi et al., 2006; Cocca, 2008*). SP conductors belonging to this style of farming are willing an optimisation of their production despite the harsh climatic and topographic conditions, by diversifying their activities, including some agri-business practices through agritourism development. Finally, "Mature businessmen" are those coming up with farming activities (processing, products retail) for the only economic motivation, and were found in high frequencies in Sette Comuni mountain community. Even here, no surprising results were found, because in that area in particular, pastures are geographically very close to the lowland farms where an intensive farming activities are performed, and as a consequence, SP are used mainly as a temporary location in order to hold animals during the summer period, in order to minimise the costs, to take profit from the pasture herbage to produce milk then to process it into cheese. Their economic motivation is high. These SP conductors are real managers and businessmen who want to increase their profit trough production, processing, and diversification of production practices.

To conclude, we can say that SP conductors interested and engaged in agritouristic activities were few but are very important to consider because of the added value that they could offer to the mountain farming. Some others were not interested in it by only trying to keep the traditional activities that they always have practised, but may be also because of some structural constraints. However, those keeping a traditional farming system are more present than the others, and their role is crucial for the maintenance of open areas and biodiversity conservation in the Alps.

Regarding SP conductors preference for those areas where improvement would be more appropriate, more emphasis was placed on the availability of facilities and equipment for products selling, which prove the fact that processing and products retail are a target of many.

Farming styles are useful instruments to understand the farmer behaviour and attitudes: *different ways for the same system but sometimes the same way for different systems!*

Farming styles are not discrete, mutually exclusive entities, but rather general explanations that exist at various levels. Therefore there is no need to develop a perfect methodology to attempt to actually identify the styles that may or may not exist and to attempt to devise the perfect classification procedure to determine what style each farmer exhibits. To this extent, farming styles will not be a definitive farmer classification scheme replacing all other market segmentation methods. More important than the quest to classify farmers is a general understanding of the existence of diversity, some understanding about how farm decisions are made and an awareness of the social legitimacy of different styles and their internal rationales (*Howden et al., 1998; Willock et al., 1999; Slee et al., 2006; Vanclay et al., 2006*).

Associating farming styles to farming systems identified in advance (*Chapter 3*), make possible the identification of optimal SP managements by revealing how farmers articulate their management goals, and therefore allow to understand where the abandonment risk is high, making public intervention more targeted and efficient.

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GENERAL CONCLUSIONS

The abandonment of traditional land use systems, generated by different social, political, and environmental factors, resulted in general and more often in a loss of pastoral value, and a decrease in biodiversity as well as landscape impoverishment (*MacDonald et al., 2000; Romero-Calcerrada and Perry, 2004; Russo, 2004*). Thus, the maintenance of livestock production systems typical of mountain agriculture has shown to be the key factor for contrasting land abandonment and for the conservation of Alpine pasture and meadow resources (*Giupponi et al., 2006; Sturaro et al., 2009*).

In the Belluno province, for example, mountain livestock systems were many and highly diversified, with six different typologies. Dairy milk production remains the most important system in the area, and traditional extensive systems prevail respect to the intensive ones. Traditional systems are those maintaining more the open areas, and diversifying their production by including on-farm cheese processing and mixed farming. However, intensive systems were those seeking the maximisation of production through milk production and retail.

Still in the same area, the farming styles identified were four and corresponded to four different ways of managing farms. A large part of farmers demonstrated their interest and wish to find new ways of farming in order to increase their revenues, mainly through agritourism development and on-farm cheese making. These farmers are thus able to ensure the economic viability of their business. That is why it is important that agricultural policies have to consider the diversity in farming systems and styles in order to better consider the support strategies for the safeguarding of the mountain farming.

Regarding the summer pastures of the Veneto region, they showed a subdivision into seven different management systems and four different farming styles. The traditional summering of milking cows was rather prevalent. Summer pastures that produce milk, cheese, or with agritouristic structures were targeting the increase of their income and a major economic wellness. These systems appear to be viable and depend mainly on the decision of farmer to continue with the activity. The other non-productive systems, mainly represented by dry and small ruminants or disadvantaged summer pastures, are those lacking adequate structures and equipment, and appear to be at risk. Economic indicators that better consider the convenience/inconvenience of the identified management systems could help defining and implementing the support strategies for efficient action plans.

Moreover, the identified farming styles were mainly of traditionalist and businessman farmers. Here again, the traditionalist prevails over the businessman. These latter have showed mainly an interest toward product transformation and agritourism activity expansion, targeting an optimisation of their income. Surprisingly, and despite their business/managerial attitudes, they demonstrate to maintain and care about the landscape. Traditionalist summer pasture conductors did not show a high economic motivation or a high interest towards agritourisms or product marketing, but they were worried about grassland maintenance and animal breeding.

Different approaches could concentrate on different regions. In general there is still much to protect in the Alps. Though their steepness, rockiness, and harsh environment are their own "best friends", maintenance of life in all its facets needs support. A consideration regarding the alpine traditional systems and styles should be done and public institutions should take into account this aspect for a sustainable alpine farming.

APPENDIX I

(Chapter 3)

THE ALPINE SUMMER PASTURES IN THE VENETO REGION: MANAGEMENT SYSTEMS

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Abstract

The aim of this study was to identify the management systems of the alpine summer pastures of the Veneto region and their geographical distribution, by means of detailed questionnaires on 417 holdings. A non-hierarchical cluster analysis identified 5 different management systems: 1: milk and cheese production, 2: milk and cheese with agritourism, 3: milk without cheese, 4: disadvantaged holdings with prevalence of sheep and goats; 5: holdings with dry and replacement cows. The different groups showed also a clear tendency to concentrate spatially in different portions of the study area. Regional policies should consider this variability to better sustain the alpine summer pasture management systems.

Key words: Alpine summer pastures, Livestock systems, Alps.

Introduction

Economic and social changes during the second half of the 20th century caused a great decline in the traditional agricultural practices (*MacDonald et al., 2000*), with the abandonment of meadows and pastures. This has been related to a loss of agricultural resources, biodiversity, and touristic appeal (*MacDonald et al., 2000, Giupponi et al., 2006, Tasser et al., 2007*). The mountainous portion of the Veneto region, in the North-eastern Italian Alps, is characterised by a significant climatic, geographic, and agricultural diversity (*Giupponi et al., 2006*). Previous surveys on the status of summer pastures in the area date back to the early 80's (*Berni and Fabbris, 1983*). This study aims at identifying the alpine summer pastures management systems, and their territorial distribution, in the Veneto region.

Material and methods

The study area (approximately 4660 km^2) corresponds to the 173 municipalities of the Veneto region classified as mountainous. An alpine summer pasture is defined here as a holding where livestock are moved over summertime from the lowland permanent farms to exploit the pastures. Information on alpine summer pastures were collected and edited from regional, local (mountain communities and municipalities) and veterinary (Regional centre for Veterinary Epidemiology) databases. This produced an updated database of 704 alpine summer pastures with their location, ownership (307 public, 365 private individual, and 32 private collective), and present status (530 active and 174 abandoned). A sample of 417 out of the 530 active holdings was then surveyed by interviewing the farmer to fill in a questionnaire on logistic (accessibility, availability of water, electricity, housing, etc.), productive (livestock held, milk processing, equipment and machinery, etc.), and economic (agri-touristic activity, direct marketing of products) features. Data collected were edited and analysed with the non-hierarchical clustering technique FASTCLUS (SAS, 2006), which is well indicated in the multivariate analysis of large datasets and is able to limit problems of redundancy and outliers (*McGarigal et al., 2000*).

Results and conclusions

The cluster analysis grouped the alpine summer pastures into 5 clusters as shown in Table 1. Cluster 1 contains 30% of the holdings, mostly of public ownership (77%) and accessible by car (94%), with an average of 3.5 employees who live in the holding during the summering period. Availability of water, electricity and housing is very good. More than 20% of the units offer bar service, 35% offer restaurant service, but only 7% can house tourists. About one third of the holdings have a milking parlour, the others use various methods of machine milking, since hand milking is sporadic; 49% of units have a refrigeration tank. Milk is processed into cheese in 70% of holdings, and carried away in the rest.

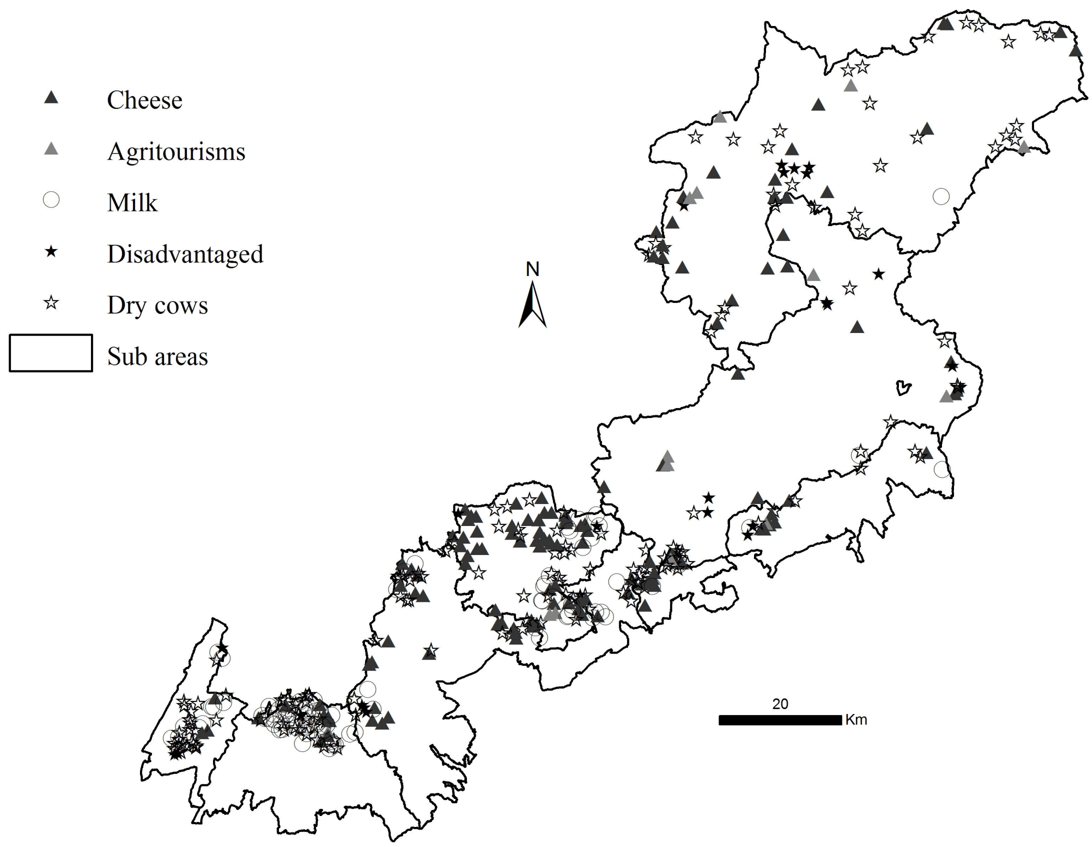
Table 1. Profiles of identified clusters. Data are given as proportion of summer units in the cluster, unless otherwise indicated.

Variable	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Number of alpine summer pastures	124	13	97	26	157
Definition of cluster	Cheese	Agritourisms	Milk	Disadvantaged	Dry cows
Public ownership	0.77	0.77	0.29	0.42	0.58
Accessible by normal car	0.94	0.92	0.91	0.60	0.82
Accessible on foot	0.04	0.00	0.02	0.28	0.08
Summering (days; mean ± SD)	117 ± 13	108 ± 21	127 ± 14	42 ± 14	115 ± 13
Total manpower (Mean ± SD)	3.5 ± 0.9	7.3 ± 1.1	2.1 ± 0.8	1.4 ± 0.6	1.5 ± 0.6
Resident *in situ* during summer	0.90	0.92	0.35	0.23	0.43
Potable water	0.96	1.00	0.65	0.56	0.70
Electricity power line	0.44	0.69	0.59	0.23	0.20
Electricity generators	0.50	0.25	0.34	0.12	0.22
Available housing	0.97	0.92	0.92	0.58	0.83
Bar	0.23	0.23	0.04	0.00	0.01
Restaurant	0.35	0.77	0.00	0.00	0.01
Accommodation for tourists	0.07	0.31	0.01	0.00	0.01
Milking parlour	0.34	0.46	0.24	0.04	0.03
Hand milking	0.07	0.00	0.01	0.00	0.02
Refrigeration tank	0.49	0.77	0.72	0.04	0.00
Cheese making	0.70	0.85	0.14	0.00	0.02
Cows on milk (% of LU/unit)	0.57	0.65	0.65	0.05	0.06
Dry/replacem. cows (% of LU/unit)	0.31	0.33	0.33	0.58	0.65
Beef cattle (% of LU/unit)	0.03	0.02	0.03	0.03	0.08
Small ruminants (% of LU/unit)	0.09	0.01	0.01	0.34	0.18

Livestock units (LU) held are mostly given by cows on milk (57%) or dry (31%). This management system is an evolution, with updated facilities and machinery, of the traditional way of exploitation of summer pastures. Cluster 2 comprises only 13 units, that differ from those of cluster 1 mainly for a further development of agri-touristic services (77% have a restaurant and 31% house tourists), which explain the higher number of manpower employed.

Cluster 3 comprises 24% of the units surveyed, mainly private owned (71%). These holdings are easily accessible but have few employees, who rarely live there during summering (35% of cases). Although dairy cattle account for almost all of the LU held, agro-touristic activity is sporadic and milk is processed *in situ* only in 14% of the units. This management system maintains a close link with the permanent farm, with the farmer visiting the alpine summer pasture only to feed and milk the animals and to collect the milk. Cluster 4 groups 26 holdings, with difficult access, a very short summering period, very few manpower and poor facilities that mostly hold dry/replacement cows and small ruminants. These are the few remaining active units amongst those located in the least productive sites. Finally, cluster 5 has 157 units, with mixed ownership (58% public). Also these holdings are characterised by poor facilities, but have a longer summering period than cluster 4, to hold mostly dry/replacement cows (65% LU) and small ruminants (18% LU).

Figure 1. Geographical distribution of the 5 management systems identified.



The study area was divided into 7 sub-areas on the basis of administrative (municipalities), morphological (contiguous mountain groups) and geographic location and closeness (figure 1). The identified clusters distributed heterogeneously amongst the sub-areas (χ^2 = 137; df = 24; P<0,001), indicating a link between geographical area and management system.

In conclusion, the summer pastures of the Veneto region showed a remarkable subdivision into different management systems. The traditional summering of milking cows remains in almost 60% of the sampled units, but with at least 3 different groups. One group comprises holdings where direct processing of milk and marketing of cheese increase revenues, with the addition of bar/restaurant service in few cases. A second, small group of holdings have been able to develop the agro-touristic offer into a major economic activity. Both these groups have easy accessibility, good facilities, and appear to be economically viable. Holdings of the third group are mostly private owned and managed as an appendix of the permanent farm, where the milk produced is taken daily to be sold. Viability of these holdings depends on the continuation of farming by the owner. The remaining 40% of alpine summer pastures has generally poor facilities and hold mainly dry/replacement cows and small ruminants, with a small sub group characterised by a very short summering period. These are the holdings whose viability appears more at risk. The different groups showed also a clear tendency to concentrate spatially in different portions of the study area. Policies aiming to sustain the alpine summer pastures of the region must take into account the variability of management systems and their geographical distribution for more targeted and efficient actions.

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APPENDIX II

(Chapter 3)

THE ALPINE SUMMER PASTURES IN THE VENETO REGION: MANAGEMENT SYSTEMS

Section 3: Synthetic evaluation and convenience/inconvenience indexes of SP management

Table A1. One Example of the complex index application.

Specific index	
Livestock index	
- Predominant animal category	
Cows in milk	0,7 *10/10 = 0,7
- Resident *in situ* yes	0,3 *1/1 =0,3
Total livestock index = 0,7 + 0,3 =1	
Environmental inconvenience index	
- Accessibility:	
Normal car	0,33* 0,25 = 0,083
- Elevation : 1303 m a.s.l.	1303/1743 (90th percentile of altitude) * 0,33 = 0,249
- Pasture	
Flat pasture (0-10%) percentage **A = 16,6%**	
Middling pending pasture (10-30%) percentage **B = 78,8%**	
Very pending pasture (>30%) percentage **C = 4,6%**	
Final pasture	((0,166*1) + (0,788*2) + (0,046*4)) = 1,926; standardized on 90th percentile: 1,926/2,192 (90th percentile of slope) * 0,33 = 0,293
Total Environmental inconvenience index = 0,083 + 0,249 + 0,293= 0,625	
Social index	
- Summering period (days) * n. of employees in farming (shepherd, farmer, dairyman)	5 employees * 123 days = 615; normalized: 615/720*0,5 = 0,427
- Agritourism opening days * n of employees not in farming (waiters, cooks, cheese-makers)	6 employees * 100 days = 600 normalized: 600/841*0,5 = 0,357
Total social index: 0,427+0,357 = 0,784 **Standardized to the maximum value of the index: 0,748/0,917 = 0,855**	
Recreational index: Recreational index * final attractiveness level	
- Recreational events: Touristic presence + Daily events	
Touristic presence (tourist/ha): 1,94	1,94*0,5 = 0,97
Daily events (Daily/ha): 26,22	
Total recreational events= 0,97+26,2 = 27,19 standardized: 27,19/63,86 (90th percentile of events)= 0,426	
- Attractiveness level of summer pasture:	
Bar No	0
Restaurant (n. of covers): 60	60/100*0,3 = 0,18
Accommodation (n. of beds): 4	4/16*0,3 = 0,075
Marketing (cheese) Yes	0,3
Final attractiveness level	0+0,2+0,075+0,3 = 0,555 Standardized to the maximum value (0,84) = 0,555/0,840= 0,661
Recreational index = 0,426*0,661= 0,281	
Environmental index	
- Summer pasture belonging to a SCI/SPA areas Yes	1

Final complex index= Livestock index * 0,4 + inconvenience index * 0,3 + social index * 0,1 + recreational index * 0,1 + Environmental index * 0,1

Final complex index = 1*0,4 + 0,625*0,3 + 0,855*0,1 + 0,281*0,1 + 1*0,1= 0,82
STANDARDIZED TO THE MAXIMUM VALUE: 0,82/0,85= 0,97

The surveyed SP unit is managed by a farmer who lives there throughout the summering period, and that breeds mainly dairy cows. This makes livestock index reaches the maximum score expected. The unit is accessible by normal car, is at an altitude of 1303 m a.s.l. and the grazed area is characterized by an intermediate slope, presenting no particular environmental inconveniences, and so, reaching a final value for that specific index of 0,625 (compared with a maximum always equal to 1).

The SP unit has an agritourism that provides many services such as restaurant, accommodation for tourists and dairy products retail. Nonetheless, tourists and visitors have shown a reduced number in that area and the agritourism, having a little availability of seats and beds. This means that the recreational index value will be reduced (0,281). Finally, the SP is located in a SCI/SPA area, and so is rewarded for the environmental role that could play. As an overall, it is a unit with many elevated single indexes (except for the tourist flow), which result in a very elevated complex index which allocate the SP unit at the top of the ranking given by all the SP units used for the index calculation.

Table A2. One Example of the simplified index application.

Specific index	
Livestock Index	
- Predominant animal category	
Cows in milk	0,7 *10/10 = 0,7
- Resident in situ Yes	0,3 *1/1 =0,3
Total Livestock Index = 0,7 + 0,3 =1	
Environmental Inconvenience Index	
- Accessibility:	
Normal car	0,25
Recreational Index: Recreational events for final attractiveness level	
- Recreational events: Touristic presence + daily events	
Touristic presence (tourists/ha area): 1,94	1,94*0,5 = 0,97
Daily events (days/ha area): 26,22	
Total recreational events = 0,97+26,2 = 27,19 standardized: 27,19/63,86 (90° percentile events)= 0,426	
- SP Attractiveness level:	
Bar no	0
Restaurant yes	0,3
Accomodation yes	0,3
Cheese retail yes	0,3
Final SP Attractiveness level	0+0,3+0,3+0,3= 0,9 Standardized to the maximum value (0,9) = 0,9/0,9= 1
Recreational Index = 0,426*1= 0,426	
Environmental Index	
- SP belonging to a SCI/SPA areas Yes	1 point

Final Simplified Index = Livestock Index *0,4 + Inconvenience Index * 0,3 + Social Index * 0,1 + Recreational Index * 0,1 + Environmental Index * 0,1

Final Simplified Index = 1*0,4 + 0,25*0,3 + 0,426*0,15 + 1*0,15= 0,69

STANDARDIZED TO THE MAXIMUM VALUE: 0,69/0,87= 0,79

APPENDIX III

Chapter 3/a

RELATIONSHIPS BETWEEN STOCKING RATE, LIVESTOCK PRODUCTION SYSTEMS AND ALPINE MANAGED GRASSLANDS

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Abstract

This study was conducted in order to identify the relationships between stocking rate, management system, topographic conditions and weed encroachment of summer pastures in "Lessinia", a pre-Alpine area in the Veneto region of north-eastern-Italy. Using the data from a field survey on 46 summer pastures (30 with dairy cows and 16 with other bovine categories), various ANOVA/ANCOVA models were used to test the effects on stocking rate of livestock category, supplementary concentrate feeding, and pasture weed encroachment, slope and elevation. Stocking rate was higher in summer pastures with dairy cows than in those with other bovine categories, and in pastures with a moderate than in those with higher slopes, but was unaffected by supplementary concentrate feeding, elevation and weed encroachment. This indicates that in the area stocking rate is not constrained by pasture productivity and is kept at sub-optimal levels. Future research is needed to elucidate the effects that the present management status may have on the evolution of pastures productivity and biodiversity value.

Keywords: Livestock systems, Alpine summer pasture, Stocking rate, Grazing management.

Introduction

In the mountain areas of the Veneto region, as in many European areas, livestock production systems have recently experienced important changes, that resulted in the abandoning or sub-optimal management of grasslands (*Giupponi et al., 2006*). In addition, management of grasslands is strongly influenced by topographic conditions, with elevation and topography being major constraints that may force to extensive utilisation (*Marini et al., 2008*). This study was conducted in the grazing system of the summer pastures of the pre-Alpine area of "Lessinia", in the western part of the Veneto region, in order to identify the relationships between stocking rate, which is a well known key management variable in determining long-term productivity of grazing systems (*Ohlenbush et al., 1994; Ziliotto et al., 2004*), category of livestock summered, topographic conditions and weed encroachment of pastures.

Material and Methods

The study area is located in the "Lessinia" mountain community, which comprises 18 municipalities in the western pre-Alpine area of the Veneto region. Summer pasture is defined here as a holding where livestock is moved over summertime from the lowland permanent farms to exploit the pastures. Forty-six summer pastures, all summering bovine livestock, were visited and the following information was collected by means of a standard interview: category and number of livestock (dairy cows or other bovine), supplementary feeding (yes, no) and length of summering period (days). Pasture area was digitized over aerial photographs (1:10000) and classes of pasture weed encroachment were determined: < 5%, from 5 to 20 % and > 20 %. Stocking rate was calculated as livestock units (LU)/pasture surface (ha), where cattle > 2 years = 1 LU and cattle from 6 months to 2 years = 0.6 LU. Mean elevation (m a.s.l.) and slope (%) of pastures were calculated from a Digital Elevation Model (DEM), with a cell size of 25 x 25 m^2, in ArcGIS 9.2®. Prior to statistical analysis, stocking rate was log-transformed to obtain a normal distribution. Stocking rate was subjected to ANOVA/ANCOVA analyses with the effects of summered livestock category (lactating cows or other bovine livestock), supplementary concentrate feeding (yes/no), weed encroachment, and elevation and/or slope, which were tested both as covariates or as fixed effects after grouping them into classes (from 1253 m to 1388 m, from 1388 m to 1517 m and > 1517 m for elevation, and from 14 to 22 %, from 22 to 27 % and > 27 % for slope) based on variability distribution. There was no significant correlation between slope and elevation ($n = 46$; $r = 0.06$; $p = 0.68$). The best model was chosen on the basis of R^2 and *RMSE*.

Results and Discussion

A description of the surveyed summer pastures is given in table 1. Thirty pastures (herein called "Dairy") summered dairy cows on milk, and 16 (herein called "Other") farmed dry cows or other bovine livestock. Season length, average elevation and average slope of pastures were very similar for the two groups. This was surprising, since dairy cows are expected to need more productive and accessible pastures than other categories. However, this discrepancy might be explained by the use of supplementary feeding, that was common in Dairy but infrequent in Other, so compensating for the differences in forage productivity.

Table 1. Descriptive statistics of the summer pastures surveyed: means (SD) and frequencies

Livestock summered	N	Season (d)	Elevation (m a.s.l.)	Slope (%)	Suppl. feeding		Pasture surface (ha)	LU
					Yes	No		
Dairy	30	124 (6)	1489 (131)	12.9 (7.3)	28	2	66 (24)	71 (28)
Other	16	126 (14)	1513 (134)	13.7 (6.8)	7	9	40 (26)	41 (25)
Total	46	125 (10)	1495 (132)	13.1 (7.2)	35	11	56 (28)	60 (30)

Average surface of pasture was only slightly larger for Dairy, but variability within groups was remarkable. However, Dairy summered on average more LU than Other.

The various ANOVA and ANCOVA models used to analyse stocking rate showed always a significant effect of livestock category (F = 6.01; $p < 0.01$ for the best model), with Dairy having a higher stocking rate than Other (Table 2). The best model showed a significant effect of slope classes with the lowest slope having higher stocking rates than the other classes (F = 3.97; $p < 0.05$). Slope tested as covariate and elevation, either when used as covariate or when used as fixed effect, never showed a statistical significance. In addition, supplementary feeding did not influence stocking rate (F = 1.16; $p > 0.05$). Finally, weed encroachment was highly variable between pastures (ranging from 5 to 50 % of the total surface) but did not influence stocking rate (F = 1.18; $p > 0.05$).

Table 2. Effects of livestock category and pasture slope class on stocking rate (LS means ± SE)

	Livestock category		Slope class (%)		
	Dairy	Other	14-22	22-27	> 27
N	30	16	22	16	8
Stocking rate (LU/ha)	$1.00^{a} \pm 0.72$	$0.73^{b} \pm 0.44$	$1.02^{a} \pm 0.75$	$0.80^{b} \pm 0.52$	$0.76^{b} \pm 0.49$

Different superscripts within column differ significantly P < 0.05 = a, b

Conclusions

Based on the general knowledge on grazing management optimisation (*Ohlenbush et al., 1994; Ziliotto et al., 2004*), stocking rate should be positively related to pasture productivity, which is in turn inversely related to elevation, slope and weed encroachment. In this survey, only slope showed the expected effect. The lack of effects of elevation and weed encroachment, in spite of their remarkable variability, suggests that in this area stocking rates are managed at sub-optimal levels and therefore are only partially constrained by pasture productivity.

Further research is needed to elucidate the evolutionary tendency of pastures that, under the present management situation, seems to be doomed to an increasing weed encroachment and shrubs-woodland colonization (*Ziliotto et al., 2004*). This is important not only in view of the forage productivity, but also of the strong impact that management conditions may have on the biodiversity value of Alpine grasslands.

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