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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). The intensive systems had larger herds, modern structures and equipment, and were strongly production oriented, whereas the 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 the 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 capability, 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 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 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 farm numbers and the abandoning of traditional extensive farming in favour of highly mechanised and intensive production practices (Caraveli, 2000; Höchtl et al., 2005; Strijker, 2005). This process has been particularly dramatic for the traditional extensive livestock farms of the Alpine region (Caraveli, 2000; MacDonald et al., 2000; Bonsembiante and Cozzi, 2005; Lasanta et al., 2006). It is generally accepted that extensive farming practices increase environmental quality and biodiversity of agro-ecosystems as compared to intensive 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 (Giuponi 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 (Mac Donald 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 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 north-eastern Italy, to analyse their attitude towards landscape maintenance, and to study the relationships between livestock systems and farming styles.

**Material and methods**

**Study area**

The study area is the province of Belluno (3678 km²), 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 grasslands). 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). Loss of farms was 55% from 1981 to 2001, and loss of cattle heads was 24%. This loss was much higher than that observed, on average, in the Veneto region (49 and 19%, respectively; ISTAT, 1981, 2001).

**Sampling scheme and data collection**

The livestock farms surveyed were sampled from a general database provided by
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 the farm and sold as cheese (yes)                                     |
| 5. Structures and equipment | Categorical (M/T/I) | The 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 number of the farm                                                                                             |
| 6. Arable crops/LU |                   | As above, divided by the LU number of the farm                                                                                             |
| 7. Mechanisation index |                   | 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 base of regional tables (Xiccato et al., 2005).                                                                          |
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 animal 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 farms surveyed, such as farm structures and equipments, livestock category farmed (dairy cows, beef cattle, sheep, goat, other), herd size and productivity, on-farm milk processing (if relevant), agrotourism services, number of employees, and on farmer attitudes, such as age, schooling, 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.

**Livestock systems and parameters**

The definition of livestock systems is based on farm (herd) size and production type, but includes 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 use of employees outside the family are indicators of the farm income level. Mixed farming and on-farm cheese making are indicators of the diversification of farm income sources. 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. The differences in terms of structures and equipment between livestock systems were tested by using a $\chi^2$ square test.

**Landscape maintenance**

The contours of open areas used by each farm were digitized on a GIS software (ArcView 3.2®) to calculate their surface. A slope map for each managed land patch was produced using a GIS software (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 the livestock systems in landscape maintenance are also detailed in Table 1. The total surface managed and its subdivision into meadows, pastures or arable crops was obtained from digitized land patches of each farm. The attitude of managed land to mechanised management was modelled with a mechanisation index. First, slope was divided into 4 classes (Benvenuti et al., 2002): the slope class L ($\leq35\%$) can be mechanised 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 class 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 for the Veneto Region (Xiccato et al., 2005; Veneto Regional Council, 2006). The total surface, the meadows, pastures and arable crop surfaces/farm, the (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 effect of livestock systems.

**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...’. The “Farming styles” of the sampled farmers were identified by adapting the “Non Hierarchical K-means clustering” (PROC FASTCLUS, SAS 2003). All the information presented in Table 2.

| MI | Percentage of pixels within mechanisation classes | 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 tools.
tion on farmer characteristics and attitudes collected by the interview were included in the analysis: age and educational level, participation in technical courses and livestock/product expositions, type of motivation and declared prospects of the farm. The profiles of each cluster were used to investigate the differences between styles. A $\chi^2$ square test was used to verify if the distribution of farming styles among livestock systems was random.

Results and discussion

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 the 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 veal calves, which were fattened with extensive practices and scarce

| Livestock system | No. of farms | LU$^1$/Farm | No. of farms with | Structure & 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: $^a,b,c=P<0.05$. 

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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 significant 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 milk 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 goats 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 are characterised by very low technological input and appear to be able to produce 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, 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 the 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 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 in 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 sur-
faces (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 the 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 in the land managed, and the attitude to maintain areas with significant slopes, were higher in the extensive as compared to the intensive systems. This difference is important when it is related to the 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 areas, which caused a concentration of the open areas along the valley bottoms, and an extensive afforestation of the valley's slopes (Cocca et al., 2007). This compositional and spatial simplification diminishes the visual attractiveness of the landscape (Hunziker et al., 1999). In addition, biodiversity may also be affected, not only because grasslands 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 grasslands are those that have the greatest wealth of species (vegetal and animal) (Marini et al., 2007).

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 signifi-

| 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 | - | 8 |
| No. of organic farms | - | 8 | 2 | 1 |
| No. of agritourisms | - | 5 | 6 | - |
| No. of employed (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 |
cant differences between livestock systems ($\chi^2=41.3; \text{df}=5; P<0.001; \text{data not in Table}$), 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.

**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 elderly (62 years of age on average), prevalently low educational level (primary school), not interested in training events and expositions, 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, exposition and events high, and the declared prospective positive (maintenance/expansion). The third group (“innovative”, 13 farmers) differed from the second because the choice for organic was rare and mean age low (33 years), but also they showed the ability to diversify income sources (almost half run an agritourism 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 agri-tourism 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 ($\chi^2=18.4; \text{df}=12; P=0.43$; 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 implications of this as respects the response of farmers to public policies is evident.

**Conclusions**

This study shows 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 than intensifying production practices.

The beef cattle farms are mostly exten-
sive, with small or moderate herd size and the prevalence of suckling cows with extensive fattening of their veal 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 shows 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 systems. 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 show higher nitrogen outputs/ha/year, although none of them exceed 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 shows 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 includes the farmers that run their farms with higher economic motivations than the forced farmers, 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 agritourism activities and/or produce cheese on the farm, and foresee the future 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. This 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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