



## Trentingrana cheese production: analysis of dairy systems

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### ABSTRACT

*This research aimed to study the relationships between livestock systems and typical products in the Trento Autonomous Province, a mountainous area of the Eastern Italian Alps. A total of 1111 dairy farms were censused in the province; a sample of 678 was surveyed collecting information on herd composition in terms of animal breeding and category, management system and quality of milk. Data were analyzed with a non-hierarchical cluster procedure that clustered farms into 6 types: modern farms with traditional feeding (86 farms); small farms with corn silage (51 farms); modern farms with unifeed and corn silage (63 farms); traditional small farms without summer pasture (146 farms); intensive farms (34 farms); traditional small farms (298 farms). The traditional systems are able to maintain a greater animal biodiversity than the intensive ones, thanks to the farming of indigenous breeds. This group of farms is largely involved in the Trentingrana cheese production, a traditional long ripened cheese (DOP) of the area, whereas the intensive systems produce milk for large distribution. This study demonstrates that in the province there is a wide variability of livestock farming systems. Traditional systems which have an important role for maintenance of landscape and farmed biodiversity are strongly connected with the typical cheese production, and this association could help in maintaining their economic viability.*

(Keywords: farming system, cluster analysis, mountain areas, dairy cattle, Trentingrana cheese)

### INTRODUCTION

In mountainous areas, physical disadvantage and extreme distances reduce competitiveness of livestock systems, and give rise to serious limits to the technical and structural adjustment. In addition, people of mountain are less adaptable because of entrenched traditions (Walther, 1986; Campagne *et al.*, 1990; Bazin, 1995). In the alpine regions of southern Europe traditional farming systems, with low production and incomes, have therefore experienced a dramatic decline (MacDonald *et al.*, 2000). The case of the province of Trento, in the north-eastern Italian Alps, is an example of this trend. Livestock farming was in the past a fundamental source of income for the population, which had permeated social and cultural traditions and had shaped a typical cultural landscape (MacDonald *et al.*, 2000; Sturaro *et al.*, 2005).

However, during the last 40 years the number of farms and livestock has dropped dramatically (Walther, 1986; MacDonald *et al.*, 2000). In the attempt of maintaining economic viability, the remaining farms have pursued an intensification process, with an increase in the average number of animals farmed/unit and a substitution of indigenous breeds with more productive breeds, such as Holstein Frisian cows (Battaglini *et al.*, 2003). Pasture and meadows which were abandoned with the closure of traditional farms

were not reutilized by the new intensive farms, with the result of an extensive spontaneous reforestation and a loss of landscape attractiveness (*Gusmeroli and Della Marianna, 2005; Cocca et al., 2007*).

In fact, maintenance of traditional farming systems based on grasslands, such as permanent meadows and alpine summer pastures, is seen today as an essential strategy for safeguarding mountain landscape and biodiversity (*Mac Donald et al., 2000; Battaglini et al., 2003; Sturaro et al., 2005; Cocca et al., 2007*). In addition to local policies for agricultural subsidies supporting extensive farming, also the economic valorization of typical dairy products may help to sustain traditional farming systems. In the Trento province there are several types of cheeses, and Trentingrana represents the most important of them. This product is part of the Grana Padano family (*Aprèa et al., 2007*), but the trademark is different, and it is a DOP product (a recognised quality trademark). Even if the production of Trentingrana is relatively small (about 4000 ton/year; consortia personal communication) when compared with that of the direct competitors (about 125,000 ton/year for Grana Padano; and about 113,000 ton/year for Parmigiano; <http://www.granapadano.com>, [www.crupa.it](http://www.crupa.it)), it is relevant for the local economy. Trentingrana is produced with partly skimmed, raw cows' milk acidified with a mixture of *Lactobacillus* and coagulated by the addition of bovine liquid rennet but, having a more restrictive production protocol, the use of lysozyme is not allowed. The ripening process is divided in two phases: the first lasts nine months and takes place in the dairies, the total period lasts 15 to 20 months and the second phase is done in a Trentingrana storehouse. At the end of both periods the product is thoroughly checked. The rounds whole cheese not fit for sale are discarded.

This paper is part of a larger research project, aimed to monitor the production chain of Grana Trentino. The specific aim of this paper is to examine the management of dairy farms in the province of Trento conferring the milk for Trentingrana cheese production.

## **MATERIALS AND METHODS**

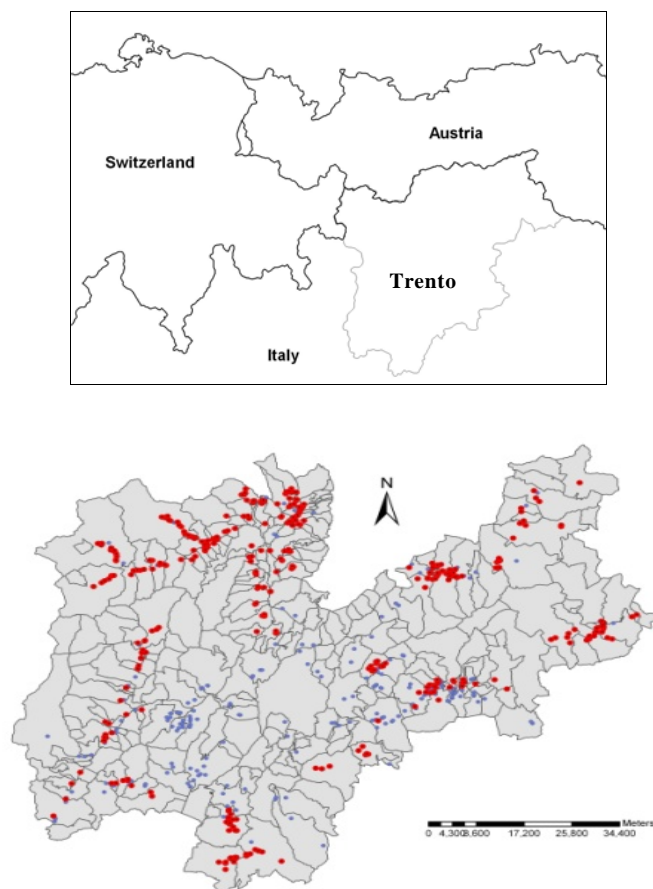
The survey was carried out in Trento that is an autonomous province of northern Italy (*Figure 1*). This province consists of 223 municipalities, all classified as mountainous for the national statistical database (*ISTAT, 2007*), covering an area of 6200 km<sup>2</sup> with a minimum altitude of 66 m asl and maximum of 3769 m asl. Vegetation is predominantly characterized by woodland (66%), followed by meadows and pastures (26%). Permanent and arable crops represent respectively 5% and 1% (*ISTAT, 2002 and 2007*). Farms with livestock account for 14% of the total holdings of the province, but with a heterogeneous distribution across the territory (*Figure 1*). In the areas interested by Trentingrana cheese production, livestock farming accounts for 40–50% of farms.

To study the characteristics of dairy systems in Trento, different databases were merged to obtain the final database. A first database, provided by the Provincial Agency for payments (APPAG), contained data on type of farm, with 1111 dairy cow herds out of a total of 2153 farms, and herd composition with information on livestock category and breeds (Brown Swiss, Holstein Friesian, Simmental, Rendena, Alpine Grey or crossbreeds). These data were merged with those of the cattle population register with a number of 1534 farms (both dairy and beef) provided by the veterinarian service of the Province (APSS), which included the farms location (georeferenced on a GIS). Then, main structural characteristics and feeding techniques of farms (see below for details) were collected by personnel of the Federazione Provinciale Allevatori Trento (FPAT) on

719 farms, and included in the database. Finally, the database was completed with the milk recording data (886 holdings; of which 724 with more than 100 controls) produced by the Federation itself using the test-day model. From the final data editing 678 farms with complete information were retained for statistical analysis. Qualitative aspects considered for the milk given to dairies are: fat, protein (and casein), lactose percentage and somatic cells score. These characters refer to bulk milk and are measured with the controls from the CONCAST-Trentingrana. In *Figure 1* the distribution of sampled farms on the territory are reported.

**Figure 1**

**The Autonomous Province of Trento and location of farms in the territory**



Red points indicate dairy farms conferring to Trentingrana, blue points other dairies

Farms were grouped by structural and management characteristics by adapting the “Non Hierarchical K-means clustering” (SAS, 2006). Observations were allocated to the groups based on the smallest Euclidean distance from the initial seeds of the cluster. Cluster centroids were updated as each observation was assigned (*Ottavianti et al.*, 2003; *Usai et al.*, 2006). The method maximizing homogeneity inside a group and diversity

within the groups offered different protocols to decide how many groups would have parted from the initial distribution. The variables included in the analysis are: housing (tie vs free stalls), feeding system (Unifeed vs traditional), use of Summer Pasture (yes/no), Corn Silage (yes/no) and Livestock Unit (LU)/Farm. The profiles of each cluster were used to investigate the differences between clusters. Proportion of each breed in the herd, average milk production and milk quality were compared among groups by using a one-way ANOVA (SAS, 2006). To verify whether there was association between farming systems and Trentingrana cheese production, the distribution across identified systems of farms conferring to Trentingrana was compared to that of the total farms sample.

## RESULTS AND DISCUSSION

Six different farming styles were identified from the non hierarchical cluster analysis of the 678 sampled farms (Table 1). The number of clusters was chosen on the base of cubic clustering criteria ( $F=431.57$ ,  $R^2=0.67$  and cubic clustering criteria=30.55, data not in table). The identified clusters were characterized by very specific features. The first is characterized by modern farms ( $n=86$ ) with large herds (80 LU/Farm), mainly free housing and traditional feeding technique with no use of corn silage and a frequent use of summer pastures. The second group identifies 51 farms with an average herd size (42 LU/Farm), traditional tie stall housing (96%), use of both traditional and unifeed (41%) feeding technique but in all cases of corn silage (100%), and a low frequency of use of summer pastures (14%). The third cluster grouped 63 farms with a large herd size (99 LU/unit), modern housing (tie stall only 13%) and feeding technique (unifeed 100%), almost no use of summer pasture (10%), and an average frequency (49%) of corn silage use. The fourth group (146 holdings) is characterized by a small herd size (32 LU/farm), traditional housing (90% tie stalling) and feeding practice with no unifeed (3%) and corn silage (0%); summer pastures are also absent (0%). The fifth cluster groups 34 intensive farms similar to those of the most productive lowlands of Italy, with a very large herd size (241 LU/farm), modern housing (100% free) and feeding (91% unifeed) and frequent use for corn silage (65%). The sixth cluster is very similar to the fourth one, differing only for the use of summer pastures (100%).

**Table 1**

### Profiles of groups identified by the non hierarchical cluster analysis

Cluster	n	Average LU/Farm (SD)	Tie Stalling %	Unifeed %	Summer Pasture %	Corn Silage %
1	86	79.8 (29.5)	22	10	70	1
2	51	42.1 (25.9)	96	41	14	100
3	63	99.4 (31.2)	13	100	10	49
4	146	31.9 (20.5)	90	3	0	0
5	34	241.1 (81.7)	0	91	21	65
6	298	21.6 (16.9)	98	0	100	0

Clusters: 1: Modern farms with traditional feeding; 2: Small farms with corn silage; 3: Modern farms with unifeed and corn silage; 4: Traditional small farms without summer pasture; 5: Intensive farms; 6: Traditional small farms

The differences between the clusters for proportion of different breeds, productivity and milk quality were significant for all variables (*Table 2*). In the Trento province is quite common to have two or more breeds in the same farm, with Brown Swiss and Holstein Friesian accounting for a main proportion in all clusters (the two breeds together accounted for 54 to 93% of LU's according to the cluster), with Holstein Friesian predominating over Brown Swiss in the more intensive systems. Simmental, Rendena and Alpine Grey were almost absent in these systems (clusters 3 and 5: 2 and 11%), while they were present with appreciable proportions in the other, traditional systems (from less than 20% in clusters 1 and 2 to 40% in cluster 6).

**Table 2**

**Analysis of differences between farming systems  
in terms of reared breeds, milk production and quality**

	<b>1 (SD)</b>	<b>2(SD)</b>	<b>3 (SD)</b>	<b>4 (SD)</b>	<b>5 (SD)</b>	<b>6 (SD)</b>	<b>F</b>	<b>P</b>
Brown Swiss (%)	54 (35)	36 (32)	35 (29)	47 (34)	24 (31)	46 (40)	5.17	< 0.001
Holstein Friesian (%)	20 (26)	42 (35)	58 (31)	20 (26)	61 (38)	7 (19)	67.64	< 0.001
Simmental (%)	11 (21)	7 (13)	2 (6)	15 (25)	5 (15)	15 (25)	4.83	< 0.001
Rendena (%)	8 (26)	7 (21)	-	3 (15)	6 (23)	12 (29)	4.47	< 0.001
Alpine Grey (%)	-	3 (13)	-	7 (23)	-	13 (29)	7.54	< 0.001
Milk (l)	23.3 (3.6)	18.9 (4.2)	25.8 (4.3)	19.3 (4.4)	27.7 (4.1)	17.7 (3.9)	81.84	< 0.001
Fat (%)	3.92 (0.24)	4.00 (0.23)	4.00 (0.24)	3.95 (0.24)	4.00 (0.32)	3.90 (0.23)	3.57	< 0.01
Casein (%)	2.75 (0.14)	2.68 (0.14)	2.75 (0.13)	2.73 (0.14)	2.76 (0.12)	2.67 (0.14)	8.71	< 0.001
Somatic Cell Score	3.22 (0.63)	3.62 (0.76)	3.24 (0.63)	3.12 (0.86)	3.26 (0.59)	3.21 (0.92)	2.82	< 0.05

Milk production ranges from a minimum of 18 kg/d in traditional farms to a maximum of 26 kg/d in intensive ones (*Table 2*). Fat and casein content and somatic cell score varied slightly between types of farm, with a general high quality, most probably due to the guidelines for Trentingrana cheese production.

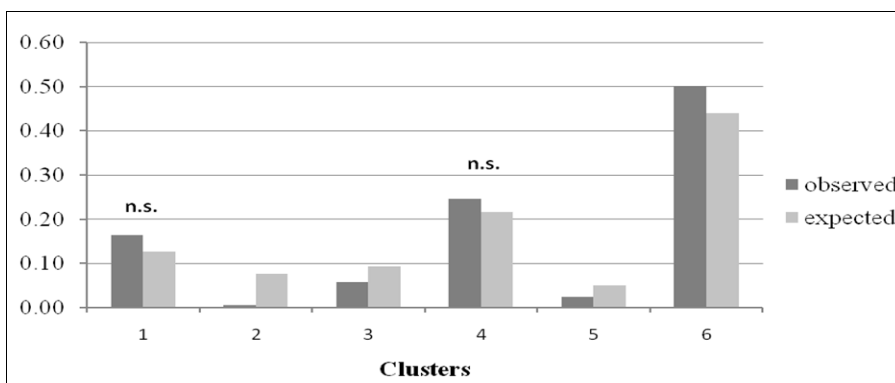
The above results confirm a general dichotomy between traditional farming systems, with small units based on use of grassland, and intensive systems with large farms based on modern feeding techniques and corn silage. Other studies conducted in the province at a farm scale (*Marini et al., 2009*), in Austria (*Schmitzberger et al., 2005*) and in the province of Belluno, bordering that of Trento (*Giupponi et al., 2006*) at a landscape scale, indicate that in mountain areas highly-producing farms support the lowest biodiversity and landscape richness. In addition, it is clear that biodiversity of farmed breeds is also much greater in traditional systems.

*Figure 2* shows that the distribution in the six clusters of the 414 farms delivering milk to Trentingrana differed significantly from that of the total sample of 678 sampled

farms ( $\chi^2=48.43$ ;  $df=5$ ;  $P<0.001$ ). As respect to what expected from the total sample of 678 farms, traditional farming systems based on grasslands were more frequent and modern, intensive systems with less use of grasslands and more use of corn silage (which is forbidden in the Trentingrana guidelines) were less frequent. This means that the role of small traditional farms is not fundamental for conservation of the landscape and biodiversity, but also for supporting typical products such as Trentingrana.

**Figure 2**

**Distribution in the 6 farming systems of farms delivering to Trentingrana (observed) as respect to that expected from the distribution of the total farms (expected)**



## CONCLUSIONS

The dairy sector of the Trento province is diversified into 6 different farming systems which differ in terms of structures, feeding techniques, farmed breeds and production level. Only milk quality is homogenous, and good, amongst systems. Traditional farms clusters, with feeding techniques based on grazing and on-farm produced forage, maintain local breeds with low productivity and are largely involved in the Trentingrana cheese production. On the opposite, modern and intensive farms which rely mostly on corn silage and maintain highly productive breeds are excluded from the production of this cheese. The association between extensive dairy farming and typical cheese production might increase the economic viability of traditional systems, and as a consequence help in maintaining a sustainable livestock sector in mountain areas. A prospective of this research will be the analysis of the relationship between dairy farms, environmental impact and landscape maintenance in Trento province.

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