

SUSTAINABILITY AND ENVIRONMENTAL IMPACT OF THE DAIRY PRODUCTION SYSTEMS IN MOUNTAIN AREAS

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ABSTRACT

Driven by a favourable milk price and by a convenient cost of the energy concentrates, in the last 2 decades the dairy farming in the mountain regions has seen a continuous growth of intensive systems of production. The intensive alpine farm can be easily recognized by its high productive records obtained by milking cows of specialized dairy breeds fed high concentrate diets. However, this system of production has shown a negative impact on both the mountain environment and the welfare of the animal and today it is questionable also from the economic point of view. Top producing dairy cows do not cope well with a tough environment like the alpine one. To preserve this fragile ecosystem, instead, there is a need to develop a dairy farming system which must be sustainable for the animal and the environment and economically feasible. This study analyses the main technical features and guidelines of this new way of dairy farming in the Alpine region along with the additional options which can increase its profitability.

Key words: dairy cattle / milk production / farming systems / environment / mountain areas / ecology / animal welfare

TRAJNOSTNI RAZVOJ IN VPLIV TEHNOLOGIJE PRIREJE MLEKA NA OKOLJE V GORSKEM OBMOČJU

IZVLEČEK

V zadnjih dveh desetletjih je v gorskih območjih nenehno naraščala intenzivna proizvodnja mleka predvsem zaradi ugodne cene mleka in koncentratov. Intenzivno alpsko kmetijo je mogoče brez težav prepoznati po visokih proizvodnih rezultatih posameznih krav molznic specializiranih mlečnih pasem, ki v obrokih dobivajo velik delež koncentratov. Tak proizvodni sistem kaže negativen vpliv na razvoj visokogorja in na dobro počutje živali, vprašljiv pa je tudi gospodarski vidik. Visoko produktivne krave molznice se ne morejo uspešno meriti s težavnim okoljem, kakršen je alpski svet. Za ohranitev tega občutljivega ekosistema je potreben razvoj take tehnologije prireje mleka, ki je sonaravna za žival in okolje, mora pa biti tudi gospodarsko učinkovita. V študiji so analizirane glavne tehnične značilnosti in priporočila za nov način prireje mleka v alpskem svetu z dodatnimi možnostmi za povečanje njene donosnosti.

Ključne besede: govedo / mleko / prireja / sistemi reje / okolje / visokogorje / varstvo okolja / dobro počutje živali

INTRODUCTION

The mountain environment is known for peculiar geographic and climatic traits which limit the possibility to carry out many types of agricultural activities in a profitable way. In the mountains, due to the short vegetative season, the low temperatures, the limited sun exposure of the land combined with factors like the ground slope, the lack of organic soil, often there are no agronomic solutions alternative to the forage production and the pasture. Therefore, the

husbandry of ruminant herbivores capable to grow and produce with these feeding sources has always been part of the mountain economy (Bonsembiante and Cozzi, 2003).

For centuries, the history of the rural communities living in the Alpine region has reported the presence of small family farms where animals, mainly dairy cattle and goats and sheep, were raised for milk and meat production. From Slovenia to the French Savoy, the common traits of this alpine farms were the housing of the animals in close barns located on the bottom of the valleys during autumn, winter and spring and the transfer of the entire herd to the pastures located on top of the mountains in early summer. This husbandry system was extensive and, from the nutritional point of view, it was based on the consumption of the local forage and the grazing on alpine pasture with an intimate relationship between the animal and the land (Andrighetto *et al.*, 1996).

The animals raised in the mountain farms belonged to local genotypes well adapted to the difficult feed and living conditions of the alpine environment. In the case of cattle, most of the animals were dual purpose breeds such as Simmenthal, Alpine Brown, Grey Alpine, Valdostana etc and, due to the limited digestible energy of the available forage, their production records were low. Since local forage and pasture were almost the only feed sources available for the animals, farmers put their maximum effort to use all the land where forage might be grown or grazed. This type of husbandry was sustainable and, by using all the land for forage production, it provided in a silent way an important environmental service called "no-food" production towards the maintenance of the alpine landscape (Andrighetto *et al.*, 1993).

THE EVOLUTION OF THE MOUNTAIN DAIRY PRODUCTION SYSTEMS

This traditional type of mountain farming was low producing in comparison with the intensive systems operating in the flat land and the main part of milk, cheese and meat produced was used by the farmer family for its self-supply. From the '60s, the birth and the development of the industrial society based on productive activities alternative to the rural ones put the mountain agriculture into a deep crisis. The tough living standards imposed by the alpine farming combined with its limited incomes became unsustainable for the main part of the workers and for the young generations in particular way. A progressive abandoning of the alpine animal husbandry was the logic consequence of the new model of social development.

Table 1. Change in number of dairy farms in the mountain area of Veneto region during the last 30 years (ISTAT, 2004)

Province	1970	1990	2000	Var%00/90	Var%00/70
Belluno	9 901	2 562	1 137	-55.6	-88.5
Vicenza	4 700	1 430	708	-50.5	-84.9
Verona	2 560	1 326	853	-35.7	-66.7
TOTAL	17 161	5 318	2 698	-49.3	-84.3

As shown in Table 1, the magnitude of this phenomenon was particularly strong in the mountain areas of the Veneto region where more than 80% of the farms with cattle went out of business in 30 years. The progressive disuse of pastures and meadows amplified a set of environmental problems such as the risk of soil erosion, avalanches, fires and moreover, it promoted a general worsening of the alpine landscape from the aesthetic point of view (Viola, 1989).

In the Italian Alps, the crisis of the extensive dairy system was severe also because more recently this way of farming was challenged by a new model of production of intensive type.

This system, which closely resembled that of the dairy farms located in the Po Valley, can be described by the following features:

- High producing cows of specialized breeds (Holstein and Brown Swiss);
- Total mixed ration with a high percentage of concentrates as feeding strategy;
- Sophisticated housing and management solutions.

The driving forces for the development of the intensive farming in the mountains were the increasing milk price, the cheaper cost of the cereals and the improvement of the roadways to connect the mountain with the food and feed trade centres of the flat land.

The impact of this system of production in the Italian mountain areas has been terrific, as shown by the data of Table 2 relative to the mountain Province of Trento. In 20 years, the number of cows of specialized dairy breed increased in this area by 240% whereas the local dual purpose breed Rendena only increased by 6%. Similar trends were observed in the mountains of Friuli, Veneto, Alto Adige, Lombardia and Piemonte with the only exception of the Valle d'Aosta. In this particular region, the colonization by the specialized dairy breed was hold back by the fact that only the milk from Valdostana breed is required for the production of the main local dairy product, the typical Fontina cheese.

Table 2. Change in number of dairy cows and in the Province of Trento during the last 20 years (AIA, 1981 and AIA, 2001)

Number of cows:	Year	
	1981	2001
Brown	4.687	8.287
Italian Holstein	463	5.014
Rendena	694	734

INTENSIVE DAIRY FARMING AND THE ENVIRONMENT

Today, the development of an intensive dairy farming system in the mountains raises important issues from many points of view. Environmentally speaking, it reduces severely the use of the land for forage production, since a large portion of the cows diet comes from outside the farm. As shown in Table 3, when a high producing dairy herd is in the barn, the feed produced in the mountain farm do not even cover the forage portion of its diet, since top quality fibre sources like lucerne or corn silage are required to sustain high milk records. In this way, the need for local forage is decreased with the consequent abandon of the marginal meadows. On the contrary, the lower nutrient requirements of a dual purpose breed reared in the same environment can be met with a larger use of the local low quality forage.

A recent case study carried out by Bizzotto (2003) in the mountains of Asiago in the Veneto region has compared the management of dairy farms which operate according to the two production systems, the traditional one and the new intensive. In the latter situation, the feeds produced outside the farms and bought by the farmer from feed suppliers represent beyond 75% of the total feed consumed by the lactating cows (Figure 1).

This percentage does not change during the summer season when cows in theory are supposed to cover their nutritional requirements by grazing on pasture. Conversely, the dependence on the feed marked is significantly reduced in the extensive farms where the percentage of feed provided by the suppliers is 40% during the part of year spent by the cows in the barn and it drops down to 20% in the grazing season.

Table 3. Comparison between intensive and extensive dairy systems operating in the mountains (Cozzi and Gottardo, 2001)

	Dairy farm	
	Intensive	Extensive
Cow breed	Holstein	Simmenthal
Milk yield, kg d ⁻¹	25–30	15–20
Feed intake, kg DM d ⁻¹	20	16
Diet characteristics:		
– forage : concentrate	50 : 50	65 : 35
– forage from the farm, % of total DM	30	65
Intake of farm feeds, kg DM d ⁻¹	6.0	10.4

A second negative environmental effect imposed by the intensive farming regards the use of the alpine grazing in the summer season. The pasture is a feeding substrate too poor to cover the nutrient requirements of high producing dairy cows (Leaver, 1985). Therefore, the transfer of these animals to the alpine sheds for the summer grazing is made possible only with the use of great amounts of concentrates to supplement their herbage intake. This in order to avoid either a severe drop in production or the impairment of the animal health due to the too negative energy balance imposed by the pasture intake. With these animals, which receive the main part of their diet in the shed at the milking, the alpine pastures have a great chance to be undergrazed. Support to this theory comes from the research of Bizzotto (2003), who has shown that the insufficient grazing of the alpine pastures by herds managed intensively had detrimental effects on the pasture quality (Figure 2). Alpine pasture grazed by high producing dairy cows showed and increased percentage of ungrazed areas along with an uncontrolled growth of nitrophylus weeds.

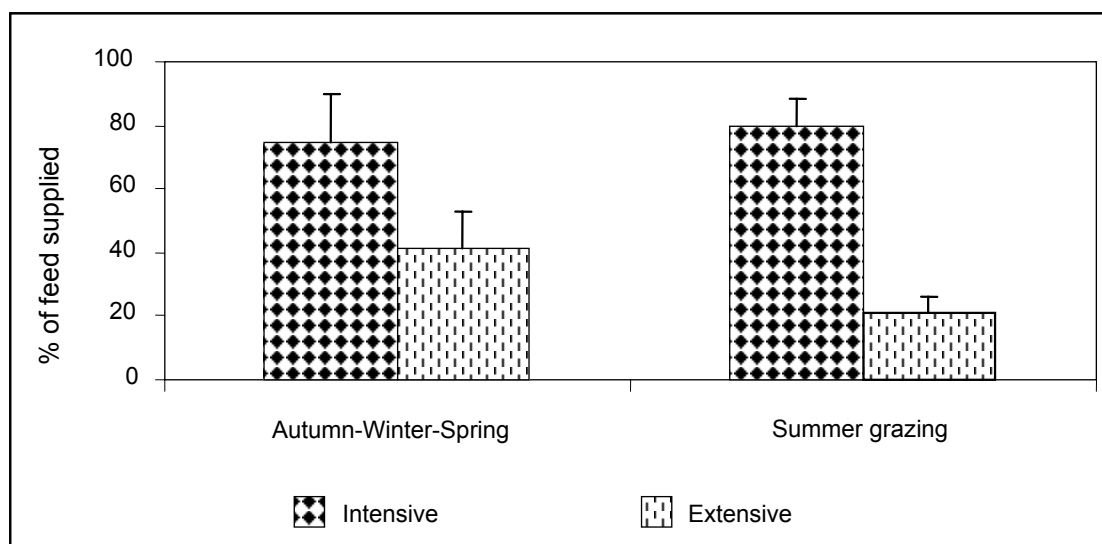


Figure 1. Percentage of feed supplied by the market in the diet of lactating cows producing under intensive or extensive system in the mountains of Asiago (from Cozzi *et al.*, 2004).

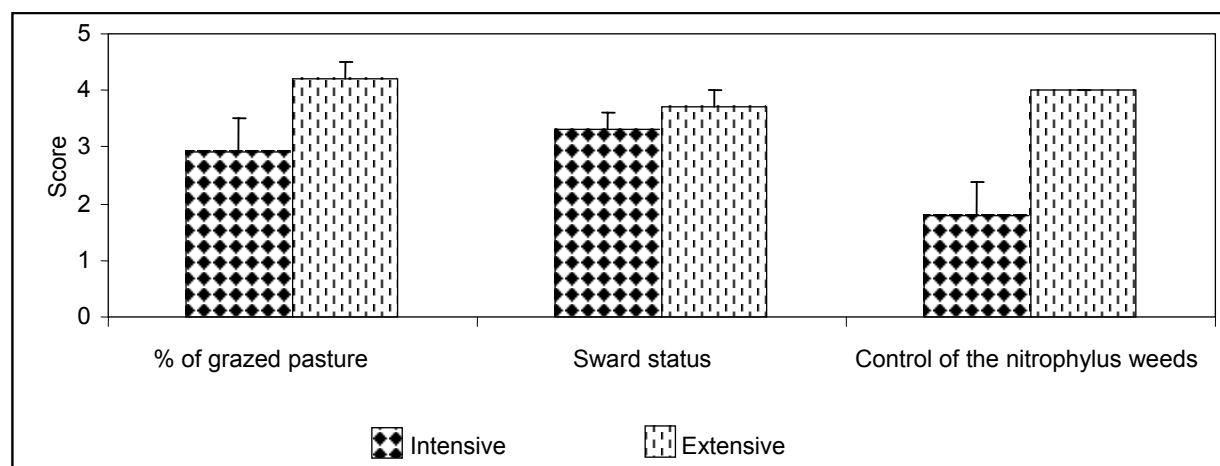


Figure 2. Visual evaluation (score from 0=very bad to 5=optimum) of alpine pastures at the end of the grazing season in farms operating intensively or extensively (modified from Cozzi *et al.*, 2004).

A further consequence of the expansion of the intensive dairy systems in the mountain is the negative environmental impact due to the excretion of an excess of Nitrogen. As mentioned above, the diet of the high producing cows is rich in concentrate feeds which replace the local forage from grassland and pastures. In this way, the main part of the dietary organic matter comes from outside the farm and the fecal output of Nitrogen exceeds the input from the intake of forage produced within the farm.

The study of Bizzotto (2003) in the Asiago mountains, showed the intensive dairy farms to produce an excess of Nitrogen in comparison to the amount which can be recycled in their land according to the regulation in force for the sustainable agriculture. The Nitrogen exceeding this threshold was 25% of total annual excretion and it would require an additional 8 ha of farm land for its complete recycling. On the contrary, the extensive farms operating in the same area were not experiencing the same problem, since their Nitrogen excretion was in a close agreement with the amount acceptable by the available farm land.

INTENSIVE DAIRY FARMING AND ANIMAL WELFARE

The welfare issue represents one of the outstanding arguments of the modern farm animal husbandry. Hurnik *et al.* (1995) provided a useful definition of animal well-being, believing that it is a condition in which physical and psychological harmony exists between the organism and its surroundings. The mountain with its severe climatic, morphological and nutritional constraints must be considered a tough environment in which farm animals cope with great difficulty. In this scenario, the only way to rear the delicate, high producing animals of specialized dairy breeds is to keep them indoors constantly and to feed them high concentrate rations. High forage diets and the alpine grazing in particular are the worst feeding condition for these “top genetic milking machines”.

Moberg (1985) considered the reproductive process sufficiently sensitive to stress to provide a reliable reflection of the animal well-being. At this regard, the study of Bizzotto (2003) in the mountains of Asiago showed that specialized cows of intensive farms had a minor longevity and a higher culling rate than dual purpose cows managed extensively (Table 3). Another welfare indicator widely applied at farm level concerns the medical treatments. Even for these parameters the data recorded by Bizzotto (2003) were very clear, since per unit of milk

production, cost and number of treatments were more than doubled in the intensive farms (Table 3).

Table 3. Calving records, days open and number and cost of pharmaceutical treatments recorded in intensive and extensive farms of the Asiago mountains (from Bizzotto, 2003)

	Dairy farm	
	Intensive	Extensive
Age at 1 st calving, months	27 ± 1.2	28 ± 2.5
Average calving age of the cows, months	46 ± 6.6	56 ± 3.5
Day open, d	138 ± 19	109 ± 10
Replacement heifers, % of the total herd	42 ± 10	33 ± 9
Medical treatments		
– Cost for drugs, €/1000 kg of milk	1 279 ± 398	523 ± 179
– Days of treatment, d/1000 kg of milk	120 ± 40	60 ± 10

DAIRY SYSTEMS AND PROFITABILITY

As previously stated, the growth of the intensive system of farming in mountain areas has been driven by its profitability which was based on an increasing milk price. Comparative studies of the milk market in some western countries have shown a negative correlation between milk price and the percentage of pasture included in the diet of lactating dairy cows (Clark and Jans, 1995).

A high milk price stimulates the farmer to address towards more expensive production tools such as the rearing of specialized dairy breeds, the wider use of concentrate feeds and the adoption sophisticated machineries and housing solutions to push the farm production up. However, the economic situation which in the past supported this type of evolution also in the mountain areas has been changing. Today, the milk price is stagnant and after the recent broadening of the EU is not realistic to foresee any future increase. Contemporary, in the feed market there is constant increase of the cost of cereals and soy-products the main constituents of energy and protein supplements for dairy cattle. This new scenario becomes day after day more critical for the milk producers located more marginally and particularly for alpine ones.

The financial analysis carried out by Bizzotto (2003) clearly showed that the profits of the intensive dairy farmers are no more higher than those of the extensive producers. Moreover, it must be pointed out that this result was obtained in a productive situation in which no specific subsidies are given to the extensive producers in return for the important service carried out by operating in an environmental friendly way.

CONCLUSIONS

The development of intensive dairy system in the mountain region has shown to be detrimental for both animal and environment and today is questionable also from the economical point of view. Top producing animals do not cope well with the tough mountain environment where pasture and forage are the only local feed sources. Therefore, the future of the dairy production in the mountains is dependent on the recovery of a more extensive way of farming which today must prove to be environmentally sustainable, animal friendly and economically feasible.

From the technical point of view, the main features of this system of production should be:

- The choice and the improvement of less specialized dairy breeds which have the size, the capability and the behaviour to better adapt to the difficult mountain environment;
- The adoption of a feeding system which aims at maximizing the use of the local feed sources through the forage production and the summer alpine grazing;
- The re-introduction of herd management guidelines in which the requirements of the lactating animals are better synchronized with the quality and availability of the local feed sources. According to this system, the calving season of all the cows should happen during the late autumn-early winter period when the animals are in the barn and they can be fed a more concentrate diet to meet the higher requirements of the early lactation. Instead, the summer grazing in the alpine pasture should represent the main feed source for pregnant animals in late lactation or entering into the dry period.
- The dependence on the feed market should be limited and in some way seasonal, addressing only to the energy and protein sources needed to supplement the farm forage.

All these strategies and their practical application must be based on robust scientific knowledge built through an interdisciplinary approach involving the agronomist, the animal breeder and the nutritionist. Moreover, in order to be effective, these solutions must be transferred to the farmers through a continuous education program.

A fundamental role for the growth and development of this sustainable form of mountain farming must be played by the public subsidy which should be determined according to the real environmental service given. In the present economy, this form of financial support is a mandatory keystone on which a low producing environmental friendly dairy system must be built. Further support to the profits of the extensive farmers might come from the labeling of specific dairy products with geographical indications and designations of origin (PDO, PGI marks) as well as from the farm conversion into the organic system of production. A positive consequence on the consumer's acceptance for the products of this farming system is also expected from the promotion "welfare friendly" labels to testify their origin from a rearing situation in which there is a good relation between the animal and the surrounding environment.

In the mountain, the beauty of the landscape represents the mandatory starting point for the development of all the outdoor and recreation activities. Therefore, the landscape preservation and valorisation is an essential tool for the growth of an other outstanding productive activity of the mountain, the tourism. In this precious, but fragile environment, recreation and agriculture should walk together and not oppose each other, as often happens in our Alps.

In a modern society, where our life is getting day after day more hectic, overwhelmed by the rhythm of the progress, the mission of the mountain environment is to become a safe harbour where we can rediscover the beauty and the genuine quietness of the nature. Only a vital and sustainable agriculture, in which there is a real use and preservation of the land will allow the maintenance of a unique jewel like our Alps.

REFERENCES

- Andrighetto, I./ Berzaghi, P./ Cozzi, G. Dairy feeding and milk quality: the extensive systems. *Zootecnica e Nutrizione Animale*, 22(1996), 241–250.
- Andrighetto, I./ Cozzi, G./ Berzaghi, P./ Zancan, M. Avoidance of degradation of alpine pasture through grazing management: investigation of change in vegetation nutrition characteristics as a consequence of sheep grazing at different periods of the growing season. *Land Degradation & Rehabilitation*, 4(1993), 37–43.
- AIA - Associazione Italiana Allevatori. *Bollettino dei controlli della produttività del latte 1981*. Roma, Anonima Tipografica Editrice Laziale, I., 1982.
- AIA - Associazione Italiana Allevatori. *Bollettino dei controlli della produttività del latte 2001*. Roma, Anonima Tipografica Editrice Laziale, I., 2002.

- Bizzotto, M. Confronto tra i sistemi di allevamento della vacca da latte nell'Altopiano dei Sette Comuni: considerazioni zootecniche e gestionali. Tesi di Laurea in Scienze Forestali ed Ambientali. Padova, Università degli Studi di Padova, I., 2003.
- Bonsembiante, M./ Cozzi, G. L'allevamento nella montagna veneta come sistema produttivo e strumento di difesa ambientale. In: *Le scienze animali al servizio dell'uomo. Alcuni scritti di Mario Bonsembiante*. Padova, Cleup Editrice, I., 2003, 211–234.
- Clark, D.A./ Jans, F. High forage use in sustainable dairy systems. In: *Recent Developments in the Nutrition of Herbivores* (Eds.: Journet, M./ Grenet, E./ Farce, M.-H./ Theriez, M./ Demarquilly, C.). Versailles, INRA, 1995, 497–526.
- Cozzi, G./ Bizzotto, M./ Rigoni Stern, G. L'allevamento da latte estensivo dà risultati migliori in montagna. *L'Informatore Agrario*, 60(2004)19, 63–67.
- Cozzi, G./ Gottardo, F. Il ruolo della zootecnia nelle aree montane. In: *Il Futuro dei Pascoli Alpini*. Mattarello (TN), Grafiche Futura, I., 2001, 129–132.
- Hurnik, J.F./ Webster, A.B./ Siegel, P.B. *Dictionary of Farm Animal Behaviour*. 2nd ed. Ames IO, USA, Iowa State University Press, 1995.
- ISTAT – Istituto nazionale di statistica. 5° Censimento generale dell'Agricoltura, 2004. <http://censagr.istat.it/>
- Leaver, J.D. Milk production from grazed temperate grassland. *Journal of Dairy Research*, 52(1985), 313–344.
- Moberg, G.P. *Animal Stress*. Bethesda, MD, USA, American Physiological Society, 1985.
- Viola, F. Alcuni spunti di ecologia circa il valore delle risorse umane e naturali nell'area montana in riferimento alla tutela ed edificabilità del territorio agricolo. *Veneto Agricoltura*, 2(1989), 21–23.