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Sustainability of small ruminant organic systems of production

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Abstract

There is an increasing interest for sustainable forms of livestock production systems, which will provide a balanced relationship between environmental, socio-cultural and economic factors. The small ruminant sector is examined with particular focus on the possibilities of improving the sustainability of small ruminant systems and on the possible role of organic production to meet the demand of sustainability. Current regulations highlighting different approaches and interpretation of organic farming among countries are reviewed. Regulations concerning organic livestock production between the US and the EU are compared. For the future development of organic farming, a strong harmonisation of rules and legislation at international and national level is needed.

The process of conversion from conventional to organic poses several problems mainly due to inadequate technical knowledge and value-added activities at farm or regional level with poorly organized marketing. Breeding strategies, feed management and disease control for small ruminant in organic farming are discussed. Animal selection should be designed to reinforce, in a sustainable manner, the relationships between animals and the environment. Feed management will require a better integration between agriculture and livestock, and a transition from monoculture to mosaic, with spatial and temporal integration of agricultural components. Possible alternatives to chemoprophylaxis are available to control helminth diseases, such as the use of homeopathic treatment, and the improvement of genetic resistance to parasite infections.

Harmonisation of rules and development of technical assistance at local level may contribute to increase sustainability of small ruminant organic farming not only in developed but also in developing countries. Certification and valorisation of organic products are key points to guarantee and promote this sector.

Keywords: Organic farming; Sustainability; Small ruminants

1. Introduction

The concept of sustainability, evoked by King (1911) at the beginning of the 20th century, reasserted itself in the 1980s when it was understood that relevant amounts of natural resources were being irreversibly

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wasted and that the future welfare of man and even the survival of humankind was becoming compromised.

Thus, in the last two decades, sustainability has involved every human activity, featuring in particular the most productive ideas from the fields of agriculture and livestock. Twenty years later, however, after much lively debate, neither the concept nor the goal of sustainability is the same for every scientist, technician, economist or politician.

Rigby and Cáceres (2001) mentioned that at least 386 definitions of sustainability were found in the literature. Today the term sustainability tends to refer to a balanced relationship among environmental, socio-cultural and economic aspects (Bauer and Mickan, 1997) which means that for a system to be sustainable, it should be technically feasible, environmentally sound and economically viable. The problem is how to meet these results for each productive agro-ecosystem.

From a physical point of view, a sustainable livestock farming system should improve, or at least maintain, the natural resources without running out of or devaluing them or generating outputs that, one way or another, reduce farming activities by, for example, giving rise to unacceptable levels of pollution. Socio-cultural sustainability concerns the landscape, natural resource management in relation to human–animal interactions and criteria for human quality of life and animal welfare.

In the past, conventional livestock farming has been impressively successful in its ability to improve the performance of farm animals and to decrease production costs. Animal farming systems are now expected to meet a number of objectives: to produce milk, meat, eggs and fibre, but also to minimize environmental damage and to improve animal welfare, biodiversity and environmental goods.

There has also been a trend over the last decade for products associated with lifestyle choices and "process quality" which ultimately justify premium prices (Bennet, 1996; Badertscher-Fawaz et al., 1998). The increase in the importance of products from organic farming is one example of this trend. Some questions which arise from this trend are as follows:

- Does the observance of the above conditions assure sustainability in Small Ruminant Production Systems (SRPS)?
- Do the organic SRPS satisfy the sustainable conditions?
- Do the regulations in force on organic production meet the demand of sustainability?

The aim of the paper is to answer these questions, to debate and to point out the possibilities, if any, and to improve the sustainability of small ruminant organic systems of production.

2. Small ruminant sector: figures, systems and sustainability

In the year 2002, sheep (1044 million) and goats (746 million) (FAOSTAT, 2003), either as heads or as animal units (AU), are the second and fourth most numerous livestock groups at the world level, respectively. Thirty-five percent of the sheep are bred in developed countries, while ninety-six percent of the goats are bred in developing countries. Small ruminant meat and milk production represents 4.8% and 3.4% of the total meat and milk produced, respectively, in the world (FAOSTAT, 2003). These percentages are smaller in developed (3.0% and 1.6%) than in developing countries (6.2% and 6.1%, respectively). Practically all goats and about 60% of ewes are milked, totally or partially, and about 95% of sheep and goat milk is transformed into typical dairy products that have a regional or local connotation of origin and quality (e.g. Roquefort, Pecorino romano, Fiore sardo, Manchego, Serra da Estrela, Feta, Indiasabal, etc.). These dairy products, plus the lean meat produced, have special characteristics (flavor, taste, aromas) and composition (proteins, fatty acids, amino acids, etc.) which allow for their designation as products of extra quality and lead, therefore, to high demand (Boyazoglu and Morand-Fehr, 2001).

A detailed analysis of the distribution of sheep and goats shows that sheep have been adapted to a variety of agroclimatic conditions where there are large and extensively managed pasture lands. Goats, by contrast, are more concentrated in dry tropical and subtropical areas of poor agricultural potential and even on marginal lands (Morand-Fehr and Boyazoglu, 1999).

Table 1 gives details of major sheep and goat farming systems, encompassing various agro-ecolog-

Table 1
Major sheep and goat farming systems in three main agro-ecological zones (El Aich and Waterhouse, 1999; Devendra et al., 2000)

Systems	Peculiarity
Farming systems within arid environment	– Pastoralism and agropastoralism – Subsistence cropping – Mobility of herds – Diversification of herd constitution – Diversification of subsistence activities – Very low levels of inputs
Farming systems within sub-humid/humid tropics	– Diversified and integrated use of resources – Low inputs
Farming systems within temperate environment	
– hilly and mountainous regions	– Seasonal movement (transhumance) – Low levels of inputs
– intensive grasslands	– High flexibility – High levels of inputs

ical zones, producing milk, meat, wool and hides from a large number of breeds of sheep and goats. Many of these systems are based mainly on extensive use of non-fertilized natural pasture resources. Almost all traditional grazing areas, at least in the Mediterranean basin, receive no application of artificial fertilizers or agrochemicals and no agricultural management other than grazing (Zervas et al., 2003). Thus, in this respect these extensive sheep and goat production systems are believed to be more close to organic and to be converted more easily from conventional to organic ones. The extensive livestock production systems of South American domesticated (*Lama pacos*, *Lama glama*) or nondomesticated (*Lama guanicos*, *Vicugna vicugna*) camelids can be considered in much the same way. These species and related farming systems will not be discussed in the present paper.

There is currently a tendency, particularly among European conservationists, to regard sheep and goat grazing as potentially detrimental, due to some widely known cases of environmental degradation caused by excessive sheep and goat numbers. However, at optimal stocking densities, sheep grazing produces similar avoidance mosaics to that of cattle grazed areas, with less palatable vegetation left to grow long whilst preferred vegetation is grazed short. Harris and Jones (1998) have shown that carefully managed sheep grazing can become a creative management tool for developing and shaping species-rich grasslands and other grazed habitats.

In many marginal areas, the seasonality of pasture growth affects both the quantity and the quality of herbage available and can limit the level of nutrition to livestock. In the Mediterranean basin, for instance, high temperature and lack of rainfall limit pasture growth in summer. The grazing capacity of mountainous grassland declines significantly during autumn and thus, the animals have to be removed into lowlands where cultivated winter cereals are used for grazing. In general, there is a difficulty in ensuring annual regularity of food supply to small ruminants and this is one of the major constraints for the mainly extensive systems. However, small ruminant production systems have evolved in marginal areas in ways which try to overcome some of the limitations imposed by the environment (Nardone, 2000), but future farming systems will need to be more compatible with positive environmental management as well as to return an adequate income to farmers.

Integrating sheep and goats into a farming operation can contribute to the economic and environmental sustainability of the whole farm. Sheep will enhance the farm's biological diversity and may better meet the economic and biological needs that would otherwise go unfilled. The relatively small investment required and the gradually increasing size of the flock make sheep production a good choice for the farmers of rural areas.

3. Organic farming

The aim of organic farming is to establish and maintain soil–plant, plant–animal and animal–soil interdependence and to create a sustainable agro-ecological system based on local resources, approaching in this way the concept of "functional integrity of systems (Thompson and Nardone, 1999). To that end, organic farming uses environmentally friendly methods of crop and livestock production, without use of synthetic fertilizers, growth hormones, growth enhancing antibiotics, synthetic pesticides or gene manipulation.

Nevertheless, organic livestock farming is not a production method which solves all problems in livestock production sustainability. It is primarily a production method for a specific premium market requiring special management qualifications. Reasons contributing to the development of this sector include its high capability for meeting increased consumer demand for environmentally friendly products associated with animal welfare. A methodical approach to organic livestock farming, largely based on the analyses of local resources (ecological, biological, economic and social) to define appropriate productive models at a regional and local level, is a serious procedure designed to meet sustainability (Ronchi and Nardone, 2003).

3.1. The figures of small ruminant organic farming in the world

The following statistical data on organic farming originate from different sources because the different databases do not as yet contain organic figures. From existing data, it seems that organic agriculture is practiced in almost all countries of the world and its share of agricultural land and farms is increasing everywhere. In 2002, organic world land area was estimated at approximately 22 million ha. With 10.6 million ha of organic land, Oceania rank in first position, Europe ranks second with 5.1 million ha and Latin America third with 4.7. million ha (Fig. 1).

At the EU-15 level, certified organic and in-conversion area increased from 0.7 million ha in 1995 to 4.4 million ha in 2002, or 3.3% of the utilized agricultural area, and 2.1% of the total farms. About half of this area is grassland and for fodder crops. The next graph, Fig. 2, shows the land area under organic management and the percentage of organic land area, respectively, of the top 10 countries worldwide.

With regard to organic livestock, the available, even limited, data also show a sharp increase in certified numbers of animals and farms of all species worldwide over the last 5 years. Official data for 1998 show that certified sheep and goats in EU-15 amounted to 0.4 million heads or 0.4% of total herds. Since then, however, the numbers of organic sheep and goats and that of organic farms have increased quite impressively, even though the share of certified sheep and goats, contrary to other animals, increased only slightly over time.

This last point may be due to small farm size and to wide geographical distribution (scattering) of the sheep/goat farms and/or to the level of the market organization (e.g. poor product availability, visibility and labeling system).

3.2. Regulations in force: strength and weakness

Legislative acts on organic farming represent an evolution in new approaches towards agricultural policy and a concrete measure for avoiding environmental problems and promoting the quality and safety of food.

In a large sense, according to regulation, organic farming practices have minimum indoor and outdoor area requirements to permit the animals their

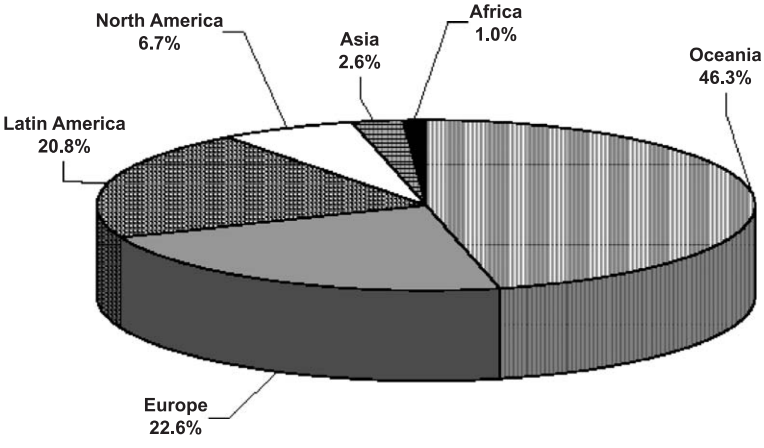

Fig. 1. Distribution of organic land area among regions (after Yussefi and Willer, 2003).

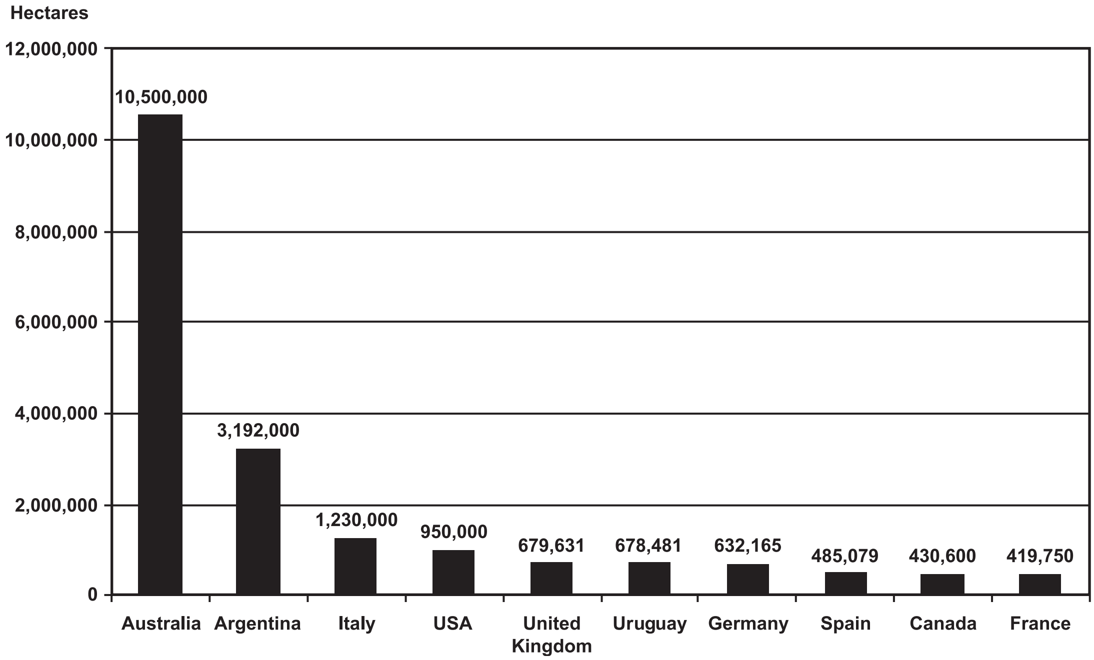

Fig. 2. Land area under organic management of the top 10 countries worldwide (after Yussefi and Willer, 2003).

natural behavior. Animals should be fed with organically produced feedstuffs but temporary derogation may be applied. Breeds should be selected taking into account their natural environment and resistance to diseases. Antibiotics and other additives are forbidden in regular feedstuffs as well as the use of hormones and growth promoters. Treatments should be based, as far as possible, on natural medical products; for therapeutic purposes, antibiotics and other chemical allopathic treatments may be used but under strict conditions and control. A further requirement is the maintenance of adequate human management to avoid environmental contamination. With regard to feedstuffs, provisions related to labeling and detailed inspection measures for industries preparing these products are being developed.

The EU regulation on organic crop production was announced in 1991 (2092/91/EEC) but it did not include any standards for livestock. For that reason, it was supplemented by regulation no. 1804/99/EC "on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs to include livestock production." This new regulation establishes rules of production for the main species: bovine, ovine, caprine, equine and poultry.

The regulation 1804/99/EC has many compromises because it must cover a great variety of livestock farming conditions differing in climate, housing, feeding, management, scale, etc. Such compromises need to be discussed and revised after implementation. Some of the rules are valid for all livestock on organic farms, without specification of species. On the other hand, cattle and small ruminants are not equally considered. Thus, while cattle are well described, sheep and goats receive scant attention. Also, a number of specifications within the regulation are clearly more applicable to intensive livestock production systems and do not take into account the extensive and/or traditional ones which more closely satisfy the organic production specifications.

The extensive/traditional sheep and goat production systems, with some minor adjustments, could obtain certification and thereby offer consumers certified and recognizable products of high quality. However, in some traditional systems, the housing conditions are really poor and do not meet the animals' minimal welfare requirements, while there are nutritional fluctuations and/or imbalances which

Table 2
Comparison of some specifications concerning organic livestock production between the US NOP and the No. 1804/99/EC Regulations

	NOP (National Organic Program)	1804/99/EC
Livestock general	Livestock does not include aquatic organisms or bees; no certification of honey or fishery products according to NOP but may be sold as (95%) organic if certified according to private/governmental organic standards by a NOP accredited certification agency.	Fishery products can only be certified according to private organic standards, apiaries need to be certified according to Regulation No. 2029/91/EEC, Annex IC.
Animals' conversion period	205.236 Conversion period – Conversion period for milk producing animals is 1 year, except when an entire herd is converted—then the first 9 months a minimum of 80% feed either organic or from land under organic management and only for the last 3 months fodder only in accordance with 205.238. – Conversion period for all livestock except dairy animals or poultry: last third of the gestation or hatching. – Poultry: organic management from the second day of life onwards.	– Conversion period for dairy animals 3 months prior to marketing. – Conversion period for sheep, goats, pigs: 4 months only. – Conversion period for broilers: 10 weeks layers: 6 weeks.
Animals' sources of slaughter stock	– Non-organic sources of slaughter-stock are not allowed, except for day old poultry (205.236.b.2).	
Animal feedstuffs	205.237.a-US requires 100% organic feed, (but obviously organic according to NOP, i.e. no forbidden inputs for at least 3 years), but there is an emergency allowance. – Livestock bedding needs to be organic if consumed by the animals.	EU rallows up to 60% "in-conversion feed" (if produced in the farm). Up to 25% conventional feed in a daily ration until 2005 August.
Animal medication	205.238.c(7) The producer must not withhold medical treatment from a sick animal in an effort to preserve its organic status. All appropriate medications must be used to restore animal's health when methods acceptable to organic production fail. Livestock treated with a prohibited substance must be clearly identified and shall not be sold, labeled or represented as organically produced. – No animal treated with antibiotics may be sold as organic. – Certain veterinary treatments that are allowed in the EU are prohibited in the US e.g. parasiticides are prohibited for slaughtered stock. – Synthetic medication may only be used if they are specifically listed in the National list.	Not explicitly specified. – Antibiotics may be used provided certain restrictions are followed.
Moving organic livestock	Organic livestock may not be moved to non-organic production units 205.236.b.1(b). The following are prohibited: – (1) Livestock or edible livestock products that are removed from an organic operation and subsequently managed on a non-organic operation may be not sold, labeled or represented as organically produced.	
Housing	Tethering is not allowed in the US (205.239.b).	– Tethering is allowed. – Far more restrictions and requirements regarding housing conditions.
Disinfection stable	No acid listed in National list, but acidic acid allowed according to the OMRI List.	Citric acid, paracidic acid and various other acids permitted.

also do not meet animals' nutritional needs. To support animal health, feeding is required to meet the physiological conditions of the animals with special emphasis on animal welfare and not on maximizing production. Further to that, in the southern part of Europe and elsewhere, there is a considerable number of small ruminant farmers who are landless but who have grazed their stock for decades on state owned land (common grazing land), or on rented land, due to existing complicated ownership legislation. According to the regulation 1804/99/EC, this landless form of animal husbandry cannot be certified as organic.

In a Europe-wide context, the use of livestock units in stocking density or stocking capacity measures is not successfully applicable because it ignores: (a) basic determinants of animal requirements such as body weight, type of production (milk or meat), physiological stage (lactation, pregnancy, dry period), productivity (milk yield, prolificacy, growth rate), environmental conditions, etc. and (b) grasslands' productivity (soil quality, rainfall, steep or plane pastures, etc.). Therefore, the certification procedure has to consider the stocking capacity of each grassland in order to allow for the proper stocking density (Rahmann, 2002).

Apart from these, interpretations of the regulation may vary between certification bodies, government authorities and member states. Differing interpretations of some points of the regulation, in addition to some new standards arising from pre-existing national legislation, have led to a situation in which we cannot identify the unified community legislation which Reg. 1804/99/EC was supposed to have provided. Indeed, if one livestock operator uses a minimum of specifications and another the maximum, they will produce two entirely different products, both of which will be certified as organic (Dimitriou, 2002).

A comparison of EU Regulation 1804/99 with the US National Organic Program (NOP) shows that the American legislation is far clearer if not stricter. The differences between the two systems are shown in Table 2.

For the future development of organic farming and also to meet WTO goals, there is a strong necessity for harmonising rules and legislation on an international level. More specifically, the EU rules for organic agriculture must be compatible with IFOAM's standards and the Codex Alimentarius.

4. Improving sustainability of organic small ruminant systems

4.1. Conversion from conventional to organic

The process of conversion of small ruminant livestock from conventional to organic seems apparently less complicated in terms of management procedures than in other livestock species and livestock production systems. The transition period from conventional to full organic certification is extremely variable depending on national regulation, type of production and the certification agency (from a minimum of 12 to a maximum of 48 months). During transition, producers experience many changes in management practices, with impacts on the entire production system (soil, crops and livestock management). Very often, the cost of transition to organic agriculture is not completely covered by conversion support payments. At the same time, during transition, animal health can be negatively affected with a higher incidence of disease and decline in productive efficiency. A tendency for a decrease in profitability can be expected in the transition period because the reduction in productivity is usually accompanied by an increase in labour, infrastructure and machinery costs (Cobb et al., 1999).

In spite of the promising perspectives of new approaches and options for preventing small ruminant diseases, a large number of problems need to be considered for large scale application, not least because of physical and climatic variability of farms.

In many small ruminant farming systems, especially when faced with marginal land with high climatic strains, feed availability (forages and concentrate supplements) represents one of the most limiting factors for a sustainable transition toward an organic system. Such is the case in the Mediterranean basin where pasture growth is limited by scarcity of rainfall and by the high potential rate of evapotranspiration (Nardone, 2000).

Other constraints related to small ruminant organic farming are: (a) the lower educational level of sheep and goat farmers compared with farmers of other animal species, which makes record-keeping difficult; (b) the lack of qualified personnel for farm management; (c) in many cases, the small size of the farm; and (d) the inadequate value-added activities at farm or regional level with poorly organized marketing.

Some of the difficulties encountered by farmers are also due to inadequate knowledge and technical information regarding organic methods. The knowledge acquisition problem is partially due to a scarcity of scientific activities and extension services. Pertinent and qualified information is needed by extension services to support farmers, especially during the phase of conversion from conventional to sustainable organic livestock systems.

4.2. Breeding strategies for organic farming of small ruminants

Selection for animals in organic farming should be used to reinforce, in a sustainable manner, the relationship between the animal and the environment in which it has to produce.

Several traits are of high priority in small ruminant organic breeding (Table 3).

Productive capacities, in particular high yielding ones, are almost exclusively the main objectives for selected breeds in conventional production systems.

Therefore, many objectives of selections are different for either livestock system. Even for shared objectives, genotype by environmental interactions may cause ranking of reproductive stock in one system unusable in the other.

These interactions are generally considered to be of little consequence if the environments are somewhat similar; instead they are of great importance if environments or genotypes differ or are extreme (Pryce et al., 2001), as can occur between organic and conventional small ruminant production systems. The suitable solution, therefore, would seem to have different selection strategies within organic and conventional production systems.

Two different strategies can be adopted to reach the selected objectives in organic farming:

1. To select animals carefully balancing the weight of each vital and productive trait [examples are available only for cattle in order to estimate the ecological total breeding value (Postler and Bapst, 2000)].
2. To cross animals of different breeds to take advantage of heterosis, more relevant for vital traits (Pryce et al., 2001; Rahmann, 2001).

For the first strategy, two restrictions should be noted: (a) the limited diffusion of artificial insemina-

Table 3
Heritability, genes and genetic markers of relevant traits for sheep in organic systems

Traits	Heritability		Genes or genetic markers	
	h^2 (min–max)	Reference		Reference
(a) General disease resistance	0.05–0.80	Raadsma, 1995		
(b) Resistance to parasite infection	0.13–0.55	McEwan et al., 1992; Gruner and Lantier, 1995; van Wyk and Bath, 2002	• NRAMP1(Chr 2) • 133 microsatellite markers • interferon gamma gene (Chr 3)	• Bussmann et al., 1998 • Beh et al., 2002 • Coltman et al., 2001
(c) Mastitis resistance			MVV-K1514 receptor gene (Chr 3)	Hotzel and Cheevers, 2002
(d) Somatic cell count	0.11–0.15	Othmane et al., 2002; Barillet et al., 2001		
(e) Longevity/lifespan	0.05[a]–0.10[a]	Reale and Festa-Bianchet, 2000		
(f) Female fertility	0.07–0.20	al-Shorepy and Notter, 1996; Snyman et al., 1998	Booroola gene (Chr 6) Inverdale (Chr X)	Montgomery et al., 1994; Davis et al., 1991
(g) Feeding characteristics (e.g. forage intake capacity)	0.10	Lee et al., 1995		
(h) Feet and legs	0.05–0.16 (for goats)	Manfredi et al., 2001		

[a] In *Ovis canadensis* (bighorn sheep in the Ram Mountain population).

tion and of new reproductive biotechnologies in small ruminant production systems; (b) the low values of heritability of several vital traits (Table 3); and (c) the foreseeable problems in selling breeding animals with low potential for productive traits outside organic farms (that underline the importance in calculating the cost/benefit of selection for the listed traits).

For the second strategy, crossing may be valid in theory but in practice, in species with limited offspring, one of the problems is the restricted advantage and another is the maintenance of a correct proportion of purebred and crossbred population. As a matter of fact, at farm level only 50% of reared animals would be well suited to organic production. After that, there is a risk for producing unwelcome further crossing than F_1, especially where the size of the flock is small, thus jeopardizing biodiversity by destroying part of the pure breeds (Nardone and Villa, 1997). This last risk must be avoided because today, 48% (331/638) of ovine breeds and 33% (110/292) of goat breeds are in an endangered or critical condition and 181 and 16 breeds, respectively, are already extinct.

In brief, although it is difficult to select animals for organic farming, it seems a better method than crossing. Molecular genetics could improve the effectiveness of selection by means of genes or genetic markers of traits beneficial to organic farming (Conington et al., 2003) such as disease resistance and parasite resistance (Crawford, 1998) and fecundity (Table 3). Thus, it will be easier to overcome the obstacles due to the low h^2 of the majority of these characteristics.

4.3. Disease control and prevention: the case of endoparasitic diseases

The control of helminth diseases represents one of the major problems in small ruminant farming. In organic farming, the problem is further aggravated by a limit of only one conventional treatment per year and double withholding period. Possible alternatives to chemoprophylaxis for parasite control are (Ronchi and Nardone, 2003):

- rational grazing management (preventive, evasive, or diluting);
- use of plant extracts;
- use of homeopathic treatment;
- use of special forage crops and improved pasture species (forage containing polyphenolic proanthocyanidins);
- development of vaccines against parasites;
- animal nutrition (improving resilience and resistance);
- biological control of parasites (by applying native or exotic natural enemies against nematode parasites);
- genetic resistance to nematode infections.

These approaches are not considered to be mutually exclusive but could be used in various combinations (Niezen et al., 1991).

Within the group of alternatives to chemoprophylaxis, the application of an appropriate rational grazing management may contribute to an effective reduction in endoparasitic disease risk in small ruminant farming. Conditional for an optimal grazing management system is the opportunity to utilize a mix of forage sources, derived from an optimal integration between permanent grassland, temporary leyes and alternative forage crops. Such conditions, together with a good availability of forage area per head and with good nutritive value, may provide a great flexibility for establishing a clean grazing system based on “rotation” as an alternative to “continuous grazing.” Unfortunately, the optimal models of grazing management can be successfully applied only if there is a favourable geographic and climatic situation. Many small ruminant farming systems, such as the “hill sheep system,” correspond to marginal lands where it is very difficult to adopt a preventative approach and minimal prophylactic use of conventional medicine.

4.4. Feeding Management

Small ruminant feeding management does not differ dramatically between organic and conventional systems. It must be highlighted, as mentioned in Section 3.2, that the feeding of small ruminants in organic farming must be based on extensive grazing systems and supplementary feed should come from the same organic farm or from other certified organic farms or feed industry (unless there is an emergency status).

The management of small ruminant organic farming is fundamentally based on the choice of an appropriate forage system and on good knowledge of climatic, soil and land topography. The objective is to guarantee a good sustainability to the overall animal production system, considering the environmental impact and animal health and productivity. For this purpose, a qualified technical service is needed to plan a specific program of grazing system improvement (optimal stocking rate, good ratio between grazing pressure and rest period) and to guarantee an optimal integration between rangeland and forestry and agricultural resources.

Organic farming requires agro-ecosystem complexity and cropping diversity, a transition from monoculture to mosaic and an optimal spatial and temporal integration of components. A possible ideal model of a small ruminant organic farm is represented by "mixed farming," in which crops and animals are considered not as diversified but as integrated components. Mixed farming presents some advantages for the farmer in terms of risk reduction and resource recycling but implies the capability to organize and manage several activities. Mixed farming implies a choice towards multiple cropping, where crop rotations spanning years and intercropping are practiced (Ronchi and Nardone, 2003). The integration of various forms of crops and animals offers synergistic interactions with a greater total contribution than the sum of their individual effects (Devendra, 2003).

The incorporation of legumes into farming systems provides many beneficial effects and play a key role in the management and sustainability of small ruminant organic livestock systems (Howieson et al., 2000). The availability of home produced protein-rich concentrates such as beans, peas and lupins contributes to reduce the necessity of commercial concentrates. The use of self-reseeding annual legumes (*Trifolium* and *Medicago* spp.) can be beneficial to low input and organic farming systems. Leguminous plants in crop rotation act as living mulches, cover crops and green manures, preventing soil degradation (Caporali and Campiglia, 2001).

4.5. Certification of valorization of organic products

In the last 10 years, there has been a great expansion in the organic market in many developed countries, particularly in Europe which represents the world's largest organic market (Willer and Yussefi, 2000). Such is the increasing demand for organic products which can only partially be satisfied by internal production. As a result, a large percentage of organic foods, particularly vegetables, is imported. The expansion of the organic market represents a good opportunity for producers in developing countries to increase the profitability of local farming systems. On the other hand, complex regulations govern the marketing of organic products with precise rules for production and commercialisation. Certification is the main aspect of organic market regulation as a means for providing protection for consumers and producers. Certification is founded on basic principles of organic farming and is regulated by specific legislation. According to EU Organic Farming Regulation (2092/91), proper inspection and certification are conditions for selling organic products. Organic products imported from countries outside the EU must respect fixed production and procedural standards. International trade in organic products is regulated by the general principle of equivalence (Barrett et al., 2002). According to this principle, regulation of organic product certification does not have to be identical among countries but must be "equivalent" or comparative in terms of effectiveness. From this perspective, all countries potentially interested in organic farming should harmonise their rules with international guidelines and regulations.

The certification process for organic foods may generate some problems for developing countries. To enter the organic trade chain, production units must maintain the organic certificate and be inspected annually. In developing countries, this represents a serious obstacle due to cost and applicability of certification. Local producers may resort to two distinct possibilities: to adopt an international certification and inspection system, usually very expensive, or to develop local certification programmes. Advantages and disadvantages are summarised in Table 4 (Barrett et al., 2002).

The prospects in developing countries for the expansion of organic farming in general, and of small ruminant organic farming in particular, seem quite small. In the case of Asia, over the next 20 years, livestock production will grow very fast and will change from small multi-purpose farms to large-scale intensive systems due to an increasing global demand for animal products and to rising income (Delgado et al., 1999). The potential contribution of organic farming to this process may be negligible in quanti-

Table 4
Advantages and disadvantages of local certification programmes (Barrett et al., 2002)

Advantages
• Lower costs for producers
• Better knowledge of local conditions and languages
• Better information flow between certification body and producer
• Development of trust between producers and certifier
• Greater possibilities for making unannounced inspections
• Retention of money in the local economy
Disadvantages
• Lack of competence and information at start-up phase
• Difficulties in obtaining international recognition
• High initial investment costs
• Conflict of interest possibly leading to struggles for control

tative terms but could be very important in preventing those negative effects of uncontrolled intensification already experienced by developed countries.

For small farmers, it would be very difficult to sustain the high costs of an international certification. A possible solution is to create a producer group and apply for group certification according to international guidelines which, however, is not at present recognized worldwide.

Certification of organic food of animal origin is more complex compared to that of vegetables. The focal point is a strict control of the long chain starting from the farm and ending at the table of the consumers (concept of traceability). For this purpose, organic animal farming and animal products must be completely separated along the entire chain. The certification label guarantees the organic origin and is a necessary condition for obtaining any kind of advantages (subsidies, market premium). Labelling "organic" is considered a process claim and does not necessarily imply a health benefit (Kouba, 2002). For a successful valorisation program of small ruminant organic farming, it would be necessary to promote not only the general but also the specific qualities of animal products (Kristensen and Thamsborg, 2002).

5. Conclusions

There is still a need to find both a single definition and a full description of the concept of sustainability of animal production systems and to indicate for each productive system how to satisfy the sustainable condition. More in general, the conventional Small Ruminant Production Systems need to improve their sustainability, thus helping the conversion from conventional to sustainable organic production.

Today, there is sufficient knowledge and technologies for improving sustainability in organic Small Ruminant Production Systems, especially concerning disease prevention and feeding management.

A fundamental question is whether to increase and improve sustainable organic Small Ruminant Production Systems in order to obtain more sustainability in the small ruminant sector or to improve sustainability in the conventional small ruminant sector in order to obtain more organic production. Several elements are in favour of the second option such as: (a) greater sustainability in each production system which is beneficial for all foreseeable human needs; (b) more sustainability in the production sector means having production with "organic" characteristics and the support of "organic" conditions of an agro-ecosystem; and (c) organic production today is only partially sustainable and its obligation to answer to market flatteries could be a weakness in obtaining complete sustainability.

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