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*SESSION*

**ANIMAL WELFARE,  
HEALTH  
AND BEHAVIOUR**

## MAIN LECTURE

# Organic livestock production systems as a model of sustainability development

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**ABSTRACT** - Organic farming and livestock production offer effective means of satisfying consumer demand for healthy and safe foods and reducing the environmental pressure of agricultural production. In Mediterranean areas organic livestock production could be considered a feasible systems to improve rural development in unfavourable areas and to maintain rural landscape. Constrains, like pasture availability during the year, determine the evolution of different strategies in livestock rearing to improve or maintain net income of population. Moreover the evaluation of the sustainability using a holistic approach using assessment criteria like Life Cycle Assessment (LCA) and Emergy Assessment could be considered models to evaluate organic and conventional livestock production sustainability and at the same time new research fields.

**Introduction** - Recent political priorities in Europe aim to rationalize agricultural production, reduce pollution, upgrade the environment, maintain rural infrastructures and meet new social concerns such as product quality and animal welfare (Burtscher, 2004). In this context organic farming, which aims to establish and maintain soil-plant, plant-animal and animal-soil interdependence (Thompson and Nardone, 1999), could be considered as laboratory to improve new knowledge about sustainability development. Nevertheless organic system is primarily a production method for a specific premium market requiring special management qualifications.

**The organic livestock production today** - Increased consumer awareness of food safety issues and environmental concerns has contributed to the grown in organic farming over the last years, although it only represent the 4% of total EU utilised agricultural area. Organic farming grew about 40% during the last five years after a period of stagnation and seems to have reached a plateau in some member state (Willer *et al.*, 2008).

Among EU countries, Italy has the largest surfaces (1,148,162 hectares) as organic land which represents the 9% of the total arable land, even if Austria has the highest share of organic crops posting 13% in 2006. Grasslands and meadows occupy more than 40% of total organic area in most of the EU countries: in Italy it represents the 23% of total organic land. About organic certified livestock (Table 1), Austria has the highest share for livestock compared to most other European countries having less than 1% share for cattle, 10% for sheep and 0.5% for pigs. In Italy (Table 2) year 2007, if compared with 2006, showed an increase in the certified cattle, sheep and goats respectively of 9.62%, 0.92% and 3.63% while pigs and poultry showed a decrease respectively of 9.54% and 14.76%.

The basic rules of organic agriculture have been formalized in the Council Regulations (EC) No, 834/2007 and 889/2008 which substitute the rules 2092/1991 on organic produc-

tion of agricultural products and foodstuffs and 1804/1999 concerning animal production. Rules on production, labelling and inspection of most relevant animal species were agreed on. The rules relate to feedstuffs, disease prevention and veterinary treatments, animal welfare, husbandry practices and the manure management. Genetically modified organisms (GMOs) and product derived from them are excluded from organic production methods. Organic farming should maintain biodiversity of the agricultural system and its surroundings. Animals should have at least access to outside areas and ruminants should largely fed through grazing on pasture. Housing systems should allow farm animals to perform all aspects of their behaviour. Disease prevention in organic livestock production is based on selection of breeds with high resistance to disease, raising livestock to promote resistance against diseases and infection trough, for example, grazing and correct housing systems. Moreover, treatment to sick animals should be carried out by the use of non-allopathic medicine although allopathic medicine is permitted, but in this case if an adult animal receive allopathic treatments more than three times during the year it cannot be considered organic anymore. The withdrawal time for allopathic medicine is set to twice the length of required by veterinarian authorities. Artificial insemination is permitted but embryo-transfer is forbidden.

Table 1. Organic livestock in Europe (source Llorens Abado and Rohner-Thielen, 2007).

Country	Bovine	Pigs	Sheep
Belgium	30,116	8,090	10,636
Czech Republic	67,956	3,108	24,230
Denmark	122,760	53,541	11,609
Greece	22,900	126,003	218,293
Spain	56,701	10,685	137,831
Italy	222,516	31,338	738,737
Latvia	21,439	6,580	6,109
Lithuania	3,843	70	3,658
Netherlands	36,259	26,200	9,340
Austria	333,826	52,170	79,551
Portugal	62,218	6,763	124,408
Slovenia	14,539	1,966	21,071
Slovak Republic	20,133	206	57,830
Finland	19,048	3,046	9,948
Sweden	91,515	27,299	34,700
United Kingdom	214,276	29,995	691,000

**Organic livestock production in Mediterranean areas**

- Extensive livestock farming represents an important chance to improve or maintain economic and social status in the mountain areas of Southern European countries. Mediterranean mountain area accounted for 36% of the total Utilized Agricultural Area (UAA) and 26% of the total EU forage production area. Moreover are raised the 51%, 83% and 18% respectively of the total EU sheep, goats and beef cattle in a large number of holdings (30% of the total), half of which are in mountain Less Favoured Areas (Pflimin and Todorov, 2003). Although the forage production area accounts for 26% of the UAA in the Mediterranean mountainous regions, these do not always include rough grazing. In Italy the area devoted to permanent pastures amounts to 3.25 millions of

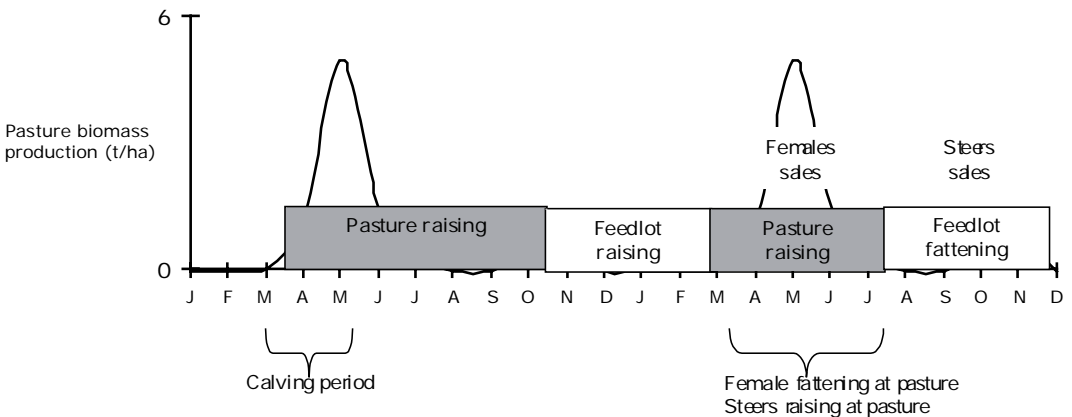
hectares (Llorens Abado and Rohner-Thielen, 2007) with a stocking rate which ranges from 2 to 0.01 LU ha<sup>-1</sup>. Pasture growth is limited by the irregular rainfall distribution during the year, coupled with high temperatures during summer and high potential rates of evapotranspira-

Table 2. Trend of organic livestock in Italy (heads) (source SINAB, 2009).

Livestock	Year						
	2001	2002	2003	2004	2005	2006	2007
Bovine	330,701	164,536	189,806	215,022	222,516	222,725	244,156
Pigs	25,435	19,917	20,513	25,508	31,338	29,736	26,898
Sheep	301,601	608,687	436,186	499,978	738,737	852,115	859,980
Goats	26,290	59,764	101,211	56,815	86,537	90,591	93,876
Chicken	648,693	939,396	1,287,131	2,152,295	977,537	1,571,310	1,339,415
Rabbits	1,682	1,377	1,068	1,109	543	2,343	871
Bees (hives)	48,228	67,353	76,607	67,713	72,241	85,489	112,812

tion (Nardone, 2000). The seasonal pasture production is responsible for nutritional constraints on extensive and organic livestock production systems which determines particular management strategies. Moreover the risk of water depletion determines a new approach in the crop and forage systems planning by improving more complex mosaic crop systems. In this context small ruminant or calf-cow systems conversion from conventional to organic seems to be less complicated than other livestock production systems. In beef production the integration of organic rules and animal management systems determines a production from animals of different weight, age, sex, and breed depending on region and tradition. Typically, beef breeds are part of a suckling-calf system. This production system may represent the best-suited to organic requirements (Younie, 1992) although the fattening should be very different from conventional systems due to the recommended 60% roughage in the daily dry matter intake and the necessity to have a grazing period corresponding to 20% of life cycle. Figure 1 shows an example of rearing management suitable in organic beef production with a combination between grazing periods and feedlot rearing systems.

Figure 1. Example of organic beef production management.



Calving period occurs in early spring, suckling cows graze till fall when calves are raised and during the following spring, steers and heifers could be raised together at pasture. Steers are better suited to rear at pasture instead young bulls because of their calm temperament.

With particular reference to Italian situation, in a three year extension service experimental project proposed by the Regional Agency for Development and Innovation in Agriculture (ARSIA) of the Tuscany Region, which aimed to modify feeding management and production system in an organic farm, Pauselli *et al.* (2008a) evaluated the possibility of steers production in Maremmana breed (Table 3) raised at pasture during two grazing seasons. Results showed a higher slaughter age, higher slaughter weight, higher carcass weight and higher dressing yield in steers respect to the young bulls ones. Steers showed lower average daily gain and similar carcass conformation and fatness score respect to the young bulls ones with a live weight gain per ha of grazing area during the experimental period of 48.35 kg (Pauselli *et al.*, 2008b). If beef production requires particular production strategies in herd management, small ruminant organic production could be quite similar to the conventional one and the main differences between the two production systems are due principally to anthelmintic and pharmaceutical treatments during the year. Nevertheless production systems are different among the different areas in function of their altitude (Table 4).

Besides the variability of climatic conditions others influencing factors should be considered in Mediterranean Basin such as the arable land reduction due to the urbanization processes in lowland areas, desertification in peri-saharian areas and in the south of European countries. Contemporary lowlands showed an intensive crop and livestock systems with a consequently, increase of risks of water pollution and water depletion. If in the first case, in the different countries, legislation limits particularly nitrogen pollution risk, about reduction of water depletion, new crop and forage cultivation method needs.

**The future challenges and the role of the research** - Although a lot of researches focused mainly on differences between organic and conventional product quality or focused on no GMO protein sources, measurement of the environmental impact of production systems and their sustainability could be considered a new challenge in research. The first step in the assessment of ecological sustainability is assessment of its envi-

Table 3. LS Means for “in vivo” and slaughter performance by year (Pauselli *et al.*, 2008a).

Parameters		Years			RMSE
		First (Young bulls)	Second (Young bulls)	Third (Steers)	
Slaughter age	d	568B	562B	642A	69.48
Slaughter weight	kg	494B	567.2A	548A	38.54
Average Daily Gain	g/d	947b	982a	924b	92.53
Carcass weight	"	258.8B	320.8A	300.48A	24.17
Dressing yield	%	52.3B	53.6B	54.82A	2.44
Carcass conformation score		7.75	7.75	7.00	1.4
Carcass fatness score		7.50	6.50	6.60	1.6

Table 4. Principal characteristics of organic farms and flocks according to purpose (Morbidini *et al.*, 2004).

	Flock purpose			Overall	
	Meat	Dual purpose	Milk	Mean	Range
Altitude (m a.s.l.)	575	616	428	490	250-750
Total farm surface area (ha)	21.5	106	213	163	13-580
Utilisable Surface Land (ha)	15	45	154	111	10-524
Flock size (no.)	80	127	579	410	58-1100
Stocking rate (heads/ha)	6.25	3.62	7	6.2	0.9-15.1

ronmental impact (Payraudeau and Van der Werf, 2005). Most researches focused on separated aspect of environmental impact such as eutrophication and acidification at farm level, whereas a little number of researches studied on the integral assessment of the environmental impact. Life cycle assessment (LCA) is a method for integral assessment of the environmental impact of products processes or services by including all phases of the life cycle. LCA is a collection and evaluation of the inputs and outputs and the potential environmental impacts of a production system, throughout its life cycle (Guinée *et al.*, 2002). LCA has been internationally accepted as a method widely used in agriculture for integral assessment of environmental impact and for an identification of hotspots (Cedeberg and Mattson, 2000; Haas *et al.*, 2001) identifying the hotspot as an element that has high contribution to the environmental burden of a product (Guinée *et al.*, 2002). For a methodological approach LCA requires the individuation of a functional unit (FU). It describes the primary function fulfilled by a product systems and enables different systems to be treated as functionally equivalent (e. g. milk or meat production), followed by the chose of the baseline impact categories such as land use, energy use, climate change, acidification, eutrophication, terrestrial or aquatic ecotoxicity. In a study involving 10 conventional and 11 organic dairy farms Thomassen *et al.* (2008) showed better environmental performance concerning energy use and eutrophication potential per kilogram of milk in the organic ones (Table 5). Nevertheless organic farms showed higher on-farm acidification potential and global warming potential per kilogram milk although total acidification potential and global warming potential per kilogram milk did not differ between the selected conventional and organic farms, instead results showed lower land use per kilogram conventional milk compared with organic milk. Hotspots in conventional farms were purchased concentrates in off farm and in total impact for all impact categories, whereas concentrates and roughage have been considered the hotspots in off farm impact in the selected organic farms.

LCA presents the limit of its complexity, in fact it is difficult to see where the assessment should stop. Emergy evaluation (Odum, 1996) could be considered a method particularly suitable to evaluate environmental impact because it is able to account all the inputs on a common basis. The terms Emergy means the embodied energy or energy memory in any product or service. It is also defined as the total amount of energy needed directly or indirectly to make any product or service (Odum, 1988). Consequently it could be used as a measure of ecological cost of a product. For convenience, units of solar energy are used as

Table 5. Results of some LCA studies (Thomassen *et al.*, 2008, adapted).

Farms n.	Production System	Land use	Energy use	Climate change	Acidification		Eutrophication	
		m <sup>2</sup> /t milk	GJ/t milk	kg CO <sub>2</sub> -eq./t milk	kg SO <sub>2</sub> -eq./		kg NO <sub>3</sub> -eq./	
					t milk	Farm ha	t milk	Farm ha
10	Conventional	1300	5.0	1400	10	140	108	1600
11	Organic	1800	3.1	1500	11	100	67	600

common unit. Human labour, information and technological devices have relatively small energy flow but high emergy flow are required for their formation and maintenance.

Emergy analysis is also used to establish a long-term sustainability and to measure environment stress. It considers a systems with large boundaries, including all inputs that contribute to the production, including the environmental ones that are taken as “free” in energy analysis (labour, etc.). Moreover the inputs are not considered only on their energy content, but are weighted by the transformities. In this way, emergy accounts for nature “labour” necessary to obtain a product. In poultry production, both in conventional, both in organic system poultry feed represented more than 50% of the emergetic flow (Castellini *et al.*, 2006). All emergy-based indicators are in favour of the organic production systems with a higher efficiency in transforming the available inputs in the final product, a higher level of renewable inputs, a higher level of local inputs and a lower density of energy and matter flows (Table 6).

Table 6. Emergy evaluation of conventional and organic chicken production (adapted from Castellini *et al.*, 2006).

Input	Emergy flow (10 <sup>14</sup> sej)/cycle	
	Conventional	Organic
Renewable input	115.88	26.58
Local non-renewable input	4.81	0.54
Imported non-renewable input	603.43	65.04
Total emergy flow	724.12	92.16

**Conclusions** - The application of EU rules on organic Livestock production in Mediterranean Basin presents a lot of constrains due to the climatic conditions that require the identification and adoption of effective solutions capable to face and solve some critical points in the productive systems by the application of modern management strategies, especially in planning and monitoring functions. Organic livestock production systems may contribute to the soil, water and landscape preservation, so the measurement of the real environmental impact of the production systems should be considered. The determination of diagnostic indicators is one of the critical point of the different assessment tools proposed



to determine the environmental impact of livestock production systems, but they must be based on robust scientific knowledge adapted to a specific geographic area.

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