

# SUSTAINABILITY OF CATTLE FARMS IN ITALY

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## ABSTRACT

This paper aimed to analyze the sustainability of Italian cattle farms, in terms of nutrient surplus and land use, greenhouse gasses emission and animal welfare. Intensive livestock farms are concentrated in Northern Italy, especially in Po valley, in which the average livestock density is 1.7 livestock unit/ha of agricultural area. A high percentage of agricultural areas are Nitrates Vulnerable Zones, and the farmers were asked to adapt the farm management to the limits established by the Nitrates Directive. Also the mitigation of greenhouse gasses emitted by ruminants, in particular enteric methane, has become an important issue for livestock sustainability and an area of research in animal science. Indeed, agriculture is responsible for about 50% of global production of methane from human activities and the largest amount is produced by rumen fermentation in cattle. Furthermore, the importance of animal welfare in intensive livestock farms is well recognized by EU citizens. For Italian cattle farms, the improvement of animal welfare is an emerging issue especially for beef and calves. Strategies aimed at improve the sustainability of Italian cattle farms are discussed, including farm management, research approaches and regional planning and policies.

**Key words:** animal welfare / cattle / environment / greenhouse gasses / Italy / sustainability

## 1 INTRODUCTION

Sustainability should be defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). In livestock production systems the concept of sustainability in one of the main issue of the last years, including environmental protection, animal welfare, biodiversity, food safety and quality, social issues and economic competitiveness (Gamborg and Sandøe, 2005). Also the evolution of European Community agricultural policy, focusing on "greening", clearly indicate the importance of environmental and social externalities connected to agriculture and animal husbandry (Kaley and Baldock, 2011). In this context, the Italian livestock sector is quite heterogeneous, with a high density of livestock unit per hectare of agricultural area in the

North, which is similar to the most intensive livestock systems of Central and Northern European countries (EUROSTAT, 2011). On the other side, the density in the other regions is low, especially into the South. These data were confirmed by the recent official census of agriculture (ISTAT, 2012). In Table 1 we reported the main statistics for Italian livestock farms, in comparison with the situation in 2000. The number of livestock farms decreased strongly in the last ten years, with few differences between macro-regions. For cattle farms, data showed a high concentration of heads in the North (almost 70% of the total number of cattle), with a general increase of farm size (from 48 heads/farm in 2000 to 64 heads/farm in 2010 in the North).

This paper aimed to analyze the major issues of sustainability of Italian cattle farms: the relationship between cattle farming and land use, which will be one of

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**Table 1:** Evolution of livestock farms in Italy in the last ten years (ISTAT, 2012)

Variable	Italy	North	Other regions
N of livestock farms 2010	209,996	91,703	118,293
N of livestock farms 2000	661,771	255,135	406,636
Livestock farms variation (%)	-68	-64	-71
N of cattle farms 2010	124,341	62,457	61,884
N of cattle farms 2000	171,994	90,245	81,749
Cattle farm variation (%)	-28	-31	-24
N of heads (cattle) 2010	5,677,953	3,998,553	1,679,400
N of heads (cattle) 2000	6,049,252	4,330,314	1,718,938
N of heads variation (%)	-6	-8	-2
Heads/farm 2010	46	64	27
Heads/farm 2000	35	48	21
Heads/farm variation (%)	30	33	29

the main pillar of next CAP reform; the contribute to the global warming, with analysis of strategies aimed at mitigate the problem; animal welfare in beef and dairy farms.

## 2 NUTRIENT SURPLUS AND LAND USE

In 2006 the Nitrates Directives was applied in Italy, with the definition of Nitrate Vulnerable Zones, which included 67% of the utilized agricultural area (UAA) of Po valley (plane area of the northern regions). As described in the introduction, the livestock density is very high (1.7 livestock unit/ha UAA), for a total of 7 million of livestock units. The most diffused crop is maize (*Zea mays* L.), which represents the main source of on-farm fodder (Grignani *et al.*, 2007). The adaptation to the new limits imposed by the Nitrates Directives may become critical for maintenance of acceptable levels of dairy and beef production in the most intensive farms. For this particular situation, European Commission accorded a derogation to the farmers of Po valley regions: with an individual request, accompanied by detailed documentation on farm management and manure storage and use, farms should be authorized to have limit of 250 kg N/ha per year, instead of 170 kg N/ha per year. Nevertheless, it is important to develop strategies to optimize the efficiency of livestock sector and reduce the environmental impact. Several studies considered the efficacy of low protein diets in reducing the nitrogen surplus. Commercially a dietary CP concentration of 130–150 g/kg DM is commonly used, but constraints introduced by the Nitrates Directive of the European Economic Community (EEC, 1991), and the high cost of soybeans, are inducing farmers to use lower CP diets. Schiavon *et al.* (2012) showed

that low protein diets and rumen-protected conjugated linoleic acid increase nitrogen efficiency (N retained/N consumed) from 0.17 to 0.23, reducing the N excretion of 30%. Another important consideration is that this strategy did not exert any influence on carcass and meat quality, as on growth performance, ensuring the economic sustainability of low protein diets (Schiavon *et al.*, 2011). The impact on sustainability of cattle farming should be monitored with different integrated approaches, such as Life Cycle Assessment (LCA) or ecological footprint (EF) (Cucek *et al.*, 2012). LCA is a structured, comprehensive, internationally-standardized tool for quantifying the environmental impact associated with processes, products or activities (EC, 2010). 'Footprint' should be defined as a quantitative measurement describing the appropriation of natural resources by humans (Hoekstra, 2008). In terms of land use, some studies evidenced a wide variability of the estimated environmental footprint of livestock products (kg of meat or kg of FCM), depending on the farm management. De Vries and De Boer (2010), in a recent review aimed at comparing the environmental impact for livestock products, obtained the following results: for beef cattle the land used to produce 1 kg of meat ranged from 27 to 49 m<sup>2</sup>, for dairy cows the estimated value ranged from 1.1 to 2 m<sup>2</sup> per kg of FCM. These data are referred to farming systems different from those typical of Italy, especially for beef farms, and we stress the importance to obtain specific information on the ecological footprint of intensive beef farms in Northern Italy. In general, it is assumed that intensification increases the efficiency of the use of resources, but we must consider that the traditional low input livestock systems of marginal areas are able to maintain ecosystems with high natural value and rich of biodiversity. For

example, mountain livestock farms play a fundamental role for the conservation of area included in Natura 2000 network. This kind of multifunction services are in line with the 'greening' reform of the CAP, which will sustain the farms able to maintain permanent meadows and protected areas. On the other side, the abandonment of traditional cattle farms caused grassland degradation and forest re-growth, with a consequent loss of biodiversity (Cocca *et al.*, 2012; Marini *et al.*, 2011).

### 3 ENTERIC METHANE AND GLOBAL WARMING

The mitigation of enteric methane ( $\text{CH}_4$ ) emitted by ruminants has become a recent and important area of research in animal science. The enrichment of  $\text{CH}_4$  in the atmosphere is considered one of the most important and highly disturbing phenomena linked to global warming. The global warming potential of methane is superior of about 20–25 times that of carbon dioxide (IPCC, 2001; Kebreab *et al.*, 2008), thus, methane is considered a greenhouse gas more potent than carbon dioxide ( $\text{CO}_2$ ) itself. In recent years the concentrations of methane gas have increased more rapidly in the atmosphere than  $\text{CO}_2$ , and this has led to the phenomenon in which infrared radiation is reflected to earth from the same methane in the atmosphere, increasing global warming. Among human activities, agriculture is responsible for about 50% of global production of methane from human activities (IPCC, 2001), and the largest source of this gas is being enteric fermentation in ruminants. The methane is produced mainly in the rumen (87%) and in small part (13%) in the intestine (Murray *et al.*, 1976). The methane produced in the rumen is a normal byproduct of the anaerobic fermentation of organic matter, and represents a loss of energy production for the animal. Generally, from 2 to 12% of gross energy consumption in cattle is lost through belching methane (Johnson K.A. and Johnson D.E., 1995). On a worldwide basis, the enteric methane from ruminants has been estimated at 17–30% of total anthropogenic methane (Beauchemin *et al.*, 2009). Growing concerns about global warming and the contribution of agriculture to climate change have led many countries to sign the Kyoto Protocol, committing to reduce greenhouse gas emissions to 1990 levels, following the guidelines of the IPCC-Intergovernmental Panel on Climate Change (UNFCCC, 1998).

Since the concentration of methane in the atmosphere is increasing, from many countries there is a strong interest in developing strategies to reduce their emissions, which, with regard to those caused by animals in livestock production it is possible to change by adjusting

the diet, but also on the genetic component of the animals. The conversion of raw materials in the rumen involves the integrated activity of various microbial species and the opportunity to make a nutritional and microbial manipulation to reduce enteric  $\text{CH}_4$  emissions from livestock has been extensively studied and examined by several research groups (Beauchemin *et al.*, 2008; McAllister and Newbold, 2008). The other possibility to mitigate the release of methane at no additional cost and providing a long lasting effect may be obtained through the use of natural variation present at the level of individual animals among which we can identify those with lower yields of  $\text{CH}_4$  (g  $\text{CH}_4$ /kg DMI; Cavanagh *et al.*, 2008). Recent forum and scientific conferences have begun to address the potential effect of the genetic component on the emission intensities of methane at the individual animal and farm level (Chagunda *et al.*, 2009). The variation of the enteric emissions of  $\text{CH}_4$  has been reported in animals (Hegarty *et al.*, 2007) between the breeds, and over time (Herd *et al.*, 2002), indicating that the mitigation of the emission of methane can also be achieved through genetic selection. Unfortunately, the measurement of direct production of the emission of  $\text{CH}_4$  from individual animals is not readily applicable. The development of new measurement techniques directly or indirectly contribute to strengthening the capacity to reduce emissions through genetic selection, in the meantime, improvements can be achieved through the selection of traits that are related to the emission of  $\text{CH}_4$ . The traits at the moment seems the most promising indirect selection for this is the RFI or residual feed intake (Hegarty *et al.*, 2007) or the prediction of methane emitted from the type of diet administered, qualitative and quantitative production by live weight, assuming zero RFI (Ellis *et al.*, 2007; Cassandro *et al.*, 2010). The direct way would be the most appropriate use of individual metabolic chambers or even the use of tracers such as sulfur hexafluoride ( $\text{SF}_6$ ), but these methods are very expensive and not entirely accurate at the individual level. Very interesting is the approach of genomic selection (Meuwissen *et al.*, 2001), a method that may become applicable, if only could be dispose of the emission of methane of at least 4–5000 individuals to be considered as a reference population to developing the genomic selection by means of a chip of thousands of genetic markers to extend to the entire population in selection. In conclusion, new perspectives and scenarios involving the livestock sector increasingly demanding the attention and responsibility towards environmental protection and major climate changes, such as limiting greenhouse gas emissions. The evidence now available suggests that the prediction of the emission of methane from cattle can also be mitigated by processes of selection and preliminary estimates show that classical breed-

ing programs could reduce methane emissions provided up to 26% in 10 years. Limit the concentration of carbon dioxide and other greenhouse gases in the atmosphere requires a technological and economic revolution. A cost to the issuer of carbon dioxide in the atmosphere will probably be required by society and some people reported values on the order of 15 euro per tons of CO<sub>2</sub> emitted.

#### 4 ANIMAL WELFARE

The importance of animal welfare is well recognized by EU citizens, who assigned, on a scale from 1 to 10, an average rating of 7.8 to the question “How important is to you that the welfare of farmed animal is protected?”. European citizens believe that animal welfare standards have been improved over the last ten years, but the large majority of the public opinion (77%) deems that further improvements are needed (EC, 2007). Specific legislations on animal welfare have been set by the European Union for several categories of farm animals. In case of cattle, the only regulation in force regards the protection of calves, imposing their group housing and the provision of a small amount of fibrous feeds in addition to the liquid diet (European Council Directives 91/629/EC and 97/2/EC). So far, no explicit rules are in force for dairy cows and beef cattle despite the publication of reference reports like “Risk factors for beef cattle welfare” by the Scientific Committee on Animal Health and Animal Welfare (SCAHAW, 2001) and several recent scientific opinions by the European Food Safety Panel on Animal Health and Welfare (AHAW, 2009a; 2009b; 2009c; 2009d and 2012) that made a deep survey on the current rearing systems identifying several housing and management risk factors capable to impair the health and behavior of these animals. There is a common opinion that rearing systems of farm animals with a high stocking rate are negatively related to the animal well being, since for the large majority of urbanized citizens, a positive perception of farm animal welfare is related to animals performing a natural behavior in a natural environment (Webster, 2001). Results of an internet survey among European consumers, showed Italian respondents (which accounted for 3% of the total sample) ranking the sufficient spaced allowance as the first “very important factor” for farm animal welfare, followed by the restriction of movement by chains and tethers (Martelli, 2009). This is particularly worrying for the Italian livestock, since the largest share of the dairy and beef cattle population is raised in the main lowland of the country, the Po Valley (Pianura Padana), according to intensive farming systems (Cozzi, 2007). Insufficient space allowance and the consequent overcrowding are by far the main limiting factors for cattle welfare in the

dairy farms of the Po Valley. These farms use the free-stall housing system with cubicles or on straw yard and the insufficient space in the walking alleys as well as the lying area has shown to increase aggressions among pen-mates, injuries, and the occurrence of lameness. Leg and foot disorders are the major welfare problems for dairy cattle and the outcomes of the risk assessment on the impact of housing on leg and locomotion problems in dairy cows (AHAW, 2009d), indicated that they are substantially more frequent when cattle are kept in cubicle houses than in straw yards.

When exposed to a high stocking density, cows reduce their ruminating behavior (Batchelder, 2000) increasing the risk of occurrence of ruminal acidosis. Overcrowding is also risk factor for udder health (AWAH, 2009c). If stocking density in straw yards is too high, this may lead to teat trampling and in this housing system, infectious udder disorders may be exacerbated when insufficient attention is given to the bedding quality and renewal. In case of free-stalls with cubicles, the risk of mastitis is enhanced by the insufficient number of cubicles which may motivate subordinate cows to lay down on the walking and feeding alleys. The inadequate cubicle design is also highly related with the risk of udder infections since movement difficulties and teat trampling may occur if cubicles are too narrow (AHAW, 2009c).

Intensive beef cattle farms of the Po Valley are specialized fattening units characterized by the finishing of young bulls and heifers mainly imported from France. Beef farms keep the animals loose in multiple pens indoor. Fattening bulls and heifers are fed high concentrate diets which are provided as total mixed rations in order to reduce the risk of the occurrence of rumen and metabolic acidosis (Cozzi, 2007). Once again in many farms, there is an insufficient space allowance due to overcrowding which impairs cattle welfare (Cozzi *et al.*, 2009). An excess of stocking density lowers feed intake and daily gain worsening the feed conversion ratio of the animals (Ingvarsten and Andersen, 1993). Bulls aggressive behaviours have shown to increase when cattle are housed with an insufficient space allowance. Time spent resting, eating and ruminating is also reduced particularly by subordinate animals which cope with more difficulty with the dominant pen-mates (Bouissou and Boissy, 2005). The outcomes of the risk assessment carried out by the EFSA Panel on Animal Health and Welfare (AHAW, 2012) have shown that overstocking impairs cattle health increasing the likelihood of respiratory diseases. Insufficient space allowance is considered a significant cause of early losses in fattening cattle due to trauma on foot and legs and tail tip necrosis (Groth, 1985). Negative effects of the overcrowding may be exacerbated by inadequate floor conditions that, besides changing animals' normal laying/



standing and walking behaviours, often cause injuries. Fully slatted floors compared to deep litter systems, have been shown to worsen bulls' health by enhancing the frequency of leg and foot injuries (Murphy *et al.*, 1987) and the occurrence of tail tip necrosis, when associated with a limited space allowance (Ingvartsen and Andersen, 1993). Littered pens are adopted for the fattening of bulls slaughtered at heavy live weights since they are considered more suitable to meet cattle needs. Straw bedding allows bulls to better perform their natural social behavior, however, when space is limiting and/or the management of litter material inappropriate, cattle may suffer of severe health and welfare problems.

From this scenario, we can conclude that simple management decisions, like the reduction of the number of pen-mates could allow a significant improvement of the cattle well-being in the intensive dairy and beef farms on Northern Italy. Farmers should be aware of the opportunity to increase their net income allowed by the implementation of welfare friendly housing practices. However a proper consumer education towards the demand of welfare friendly milk and beef meat appears the strongest tool to drive the entire productive chain to the welfare target.

## 5 CONCLUSION

This paper evidenced that the sustainability of Italian cattle farms present some concerns. In particular, the Nitrates Directive require a strict link between animal husbandry and agricultural land management, and the intensification process developed in the Po valley cause a critical situation for several farms. In the perspective of greening evolution of CAP reform, the farms able to offer positive externalities on the environment and to maintain a diversified agricultural landscape will be sustained, and the situation of intensive dairy and beef cattle of Northern Italy is unfavorable. Different strategies should be applied to improve the sustainability of Italian cattle farms. In the Po valley the efficiency of livestock sector, in terms of land, nutrient and energy use, should be improved working at different scales: farm management, local and regional planning, research application (for example aimed at reduce the enteric methane output). In the mountain and marginal areas, the main problem is the economic sustainability of farms, and the abandonment of traditional low input farms caused the loss of several positive externalities. Farm diversification and promotion of high quality products such as PDO cheeses should help to maintain these farming systems, and to preserve the territory. Also the improvement of animal welfare in intensive livestock systems is a strong request

from public opinion, playing a central role for social sustainability of cattle farms. In general, farm management, research approaches, environmental planning and policy, and consumer education must be oriented to improve the sustainability of Italian cattle farms.

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