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Agricultural systems and livestock concentration in the region of Emilia Romagna (Italy)

E. FRAZZI, F. CALEGARI, S. TSEGAY AND M. VINCINI

Abstract

A GIS multi-temporal analysis of the rotational importance of grassland, obtained by remote sensing, and livestock concentrations was conducted on farming systems of an area of the Po plain (Piacenza, Parma and Reggio Emilia provinces in the Emilia Romagna region), highly specialized for dairy and “salami” products. The analysis has revealed local levels of farming intensification that could be detrimental, on a long-term basis, to the environmental compatibility of farming systems. However, the existence of specific regulations for milk production for Parmigiano-Reggiano cheese, including the ban on feeding of corn silage, has been a key factor for maintaining a sustainable farming system in the area of origin of the typical cheese. Swine breeding was specifically addressed as a critical factor for farming systems modification.

KEYWORDS. Farming systems, Grassland, Parmigiano-Reggiano, Swine breeding, Breeding intensification.

Introduction

In most agricultural systems of the European Union farming intensification and specialization have increased pressure on the environment. One relevant process, common to all highly profitable agricultural areas in Italy but also in France, Germany, Belgium and Holland, is the reduction of the rotational role of grassland (Alard and Poudevigne, 1997).

In agricultural areas of Italy specialized for animal breeding, corn monoculture has replaced permanent and rotational forage crops, like meadows and grassland, reducing the landscape mosaic heterogeneity and biodiversity (Frazzi et al., 1999; Vincini, 1999) These changes involve relevant environmental aspects such as the conservation of soil fertility (erosion, decrease of soil

organic matter) and the vulnerability of the agri-ecosystem to soil and water pollution (nitrates, phosphates, pesticides).

In traditional mixed farming these cultures, characterized by long tillage cycles, perform several crucial agri-ecological actions such as the promotion of soil fertility by the conservation of soil fauna and soil organic matter and the mitigation of soil erosion and water pollution by providing vegetation cover in winter. Water pollution by pesticides leaching is mitigated by providing a filter action and a non-chemical agronomic weed control, whereas nitrate leaching is reduced by the presence of a vegetation cover in winter (Baudry, 1993).

A multi-temporal analysis of remotely sensed data confirmed for the Po plain the existence of this general tendency towards the decrease of rotation role of grassland. On the other hand, the existence of a relevant exception is noticed in the area of origin of Parmigiano-Reggiano cheese in the Emilia-Romagna region, where grassland showed a slight increase in the period 1987-1999 (Frazzi et al., 2002). In this area haymaking is the basis for feeding cows as a consequence of the ban on feeding of corn silage. The ban was adopted to reduce spore-forming bacteria in milk used for the Parmigiano-Reggiano production.

The present work reports the results of a multi-temporal GIS analysis of the rotational importance of grassland and livestock concentrations in the province of Piacenza, Parma and Reggio Emilia, the former obtained by remote sensing and the latter from the last two national agricultural censuses (ISTAT 1992; ISTAT 2002). Among the three provinces, characterized by high levels of animal breeding, Parma and Reggio-Emilia belong to the Parmigiano-Reggiano area of origin. The work addresses the degree of integration between farming and animal breeding. In the study area, intensive swine breeding is specifically considered as a critical factor for farming systems modification and for their environmental compatibility.

Materials and methods

A maximum likelihood classification of multi-temporal Landsat Thematic Mapper™ data was carried out in order to estimate the rotational importance of grassland and permanent meadows on 1987 and 1999 growing seasons for the agricultural area located in the plain of the Piacenza, Parma and Reggio Emilia provinces. The Landsat TM data selected to effectively differentiate grassland and permanent meadows from other crops were for 29 April, 3 August 1987, and 29 September 1999. Training sites used for the classification of 1987 TM data were collected from records of the experimental farms of the Regione Emilia Romagna; whereas, field surveys were conducted in the study area in 1999. Remote sensing was used for the evaluation of grassland area because of the lack of differentiation between grassland and other forage crops, characterized by shorter cycles, in the national agricultural censuses (ISTAT). Cattle and swine data, as well as total agricultural area (SAU, Superficie Agricola Utile), were extracted from 1990 and 2000

agricultural censuses. Census data and grassland area estimates were referred to administrative district boundary layers (comuni) in a GIS database.

Results

As shown in Figure 1, where the ratio of grassland area estimated for 1999 to the total agricultural area from Census 2000 (ISTAT, 2002) is reported for each community, the relative rotational presence of grassland is high in the Parma and Reggio Emilia provinces (i.e. the Parmigiano-Reggiano producing area) whereas in Piacenza province, traditionally characterized by a very similar farming system, grassland have been reduced to a marginal presence.

The number of animals (swine and cattle) for the three provinces from Censuses 1990 and 2000 is reported in Figure 2 (ISTAT 1992; ISTAT, 2002). As visible in Figure 2, livestock concentrations show comparable values for the three provinces with the exception of swine breeding, highly concentrated in the Reggio Emilia area.

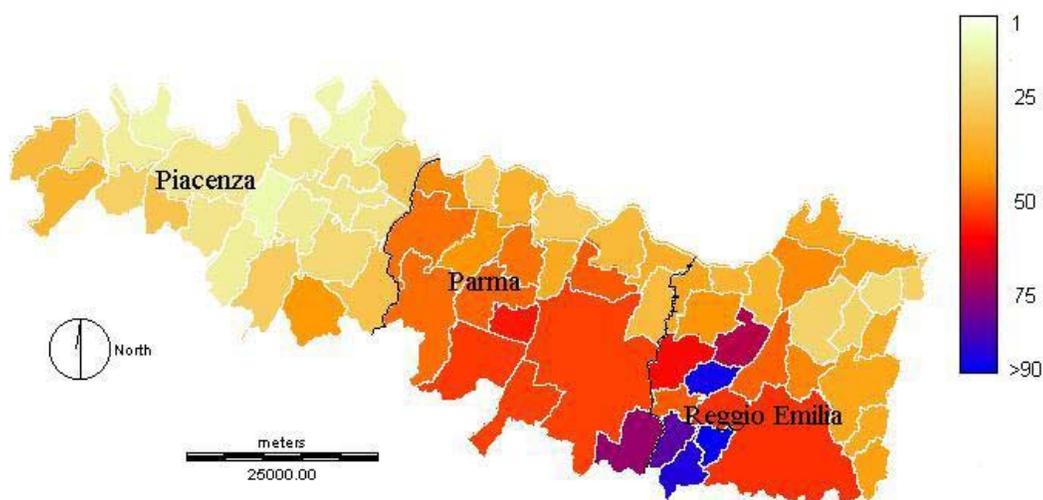


Figure 1. Grassland area as estimated from Landsat TM (1999) in (%) of total agricultural area (Census Data 2000) for districts in the three provinces.

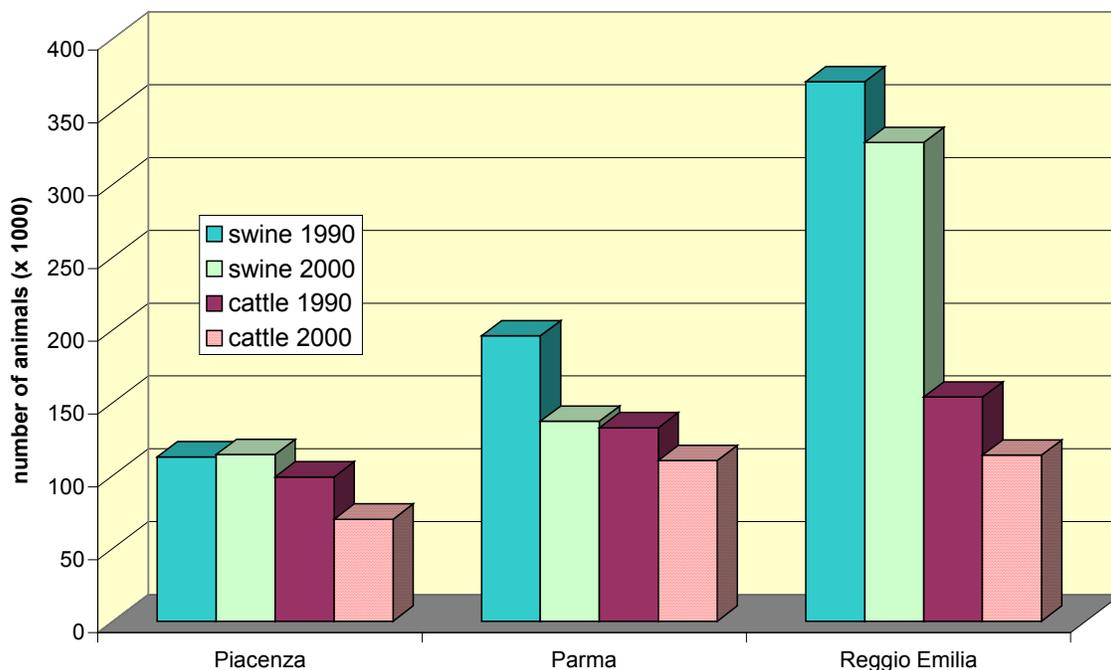


Figure 2. Total number of swine and cattle from census data 1990 and 2000 for the three provinces

In general the total number of swine and cattle in the three provinces has decreased within the decade 1990-2000. Nevertheless, the process of breeding intensification with the enlargement of farm size and the associated decrease of the number of farms has been marked in the Emilia Romagna where livestock concentrations are particularly high. As visible in Figure 3, where the number of animal breeding farms and the number of animals per farm from the last four agricultural censuses are reported for the whole Emilia Romagna region, swine breeding was especially affected by specialization and intensification processes.

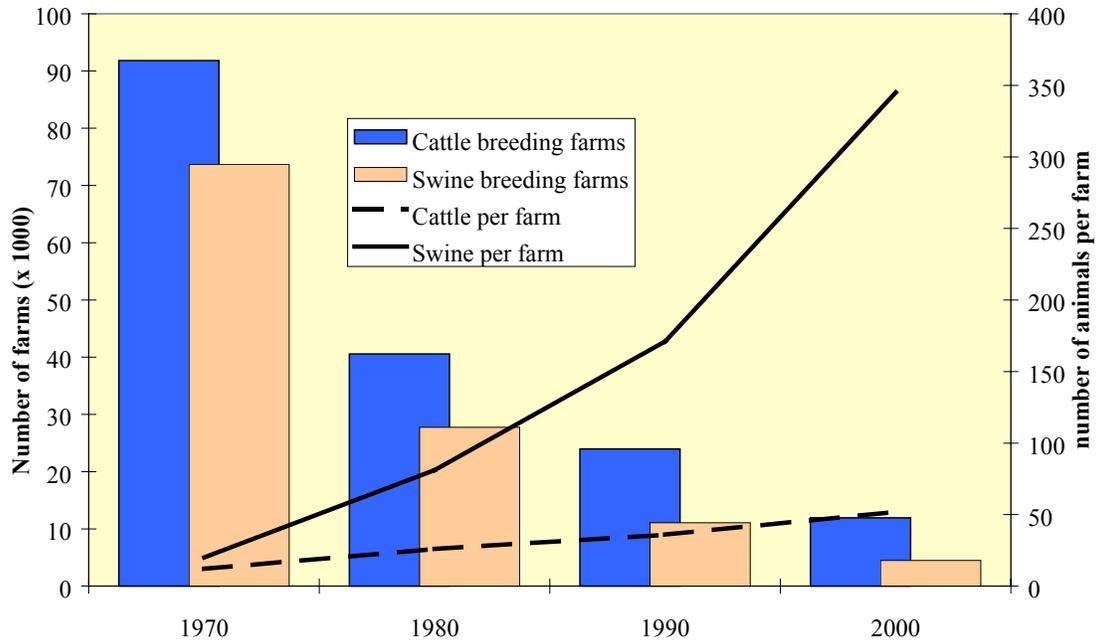


Figure 3. Trend of total number of animal breeding farms and of animals per farm in the last thirty years in the Emilia Romagna region (ISTAT data).

The average number of swine per farm has increased in a decade from 171 to 345 head with 84% of the animals belonging to farms with more than 1000 head each.

In spite of the presence of a few huge farms with poor availability of agricultural land for manure disposal, swine breeding in the Emilia Romagna region is generally still integrated with agricultural farms. Particularly in the area of origin of Parmigiano-Reggiano cheese, swine breeding is connected to co-operative dairies managed by milk producing farmers. In this co-operative farming system, whey available from dairies is employed for swine feeding and swine manure is distributed to partner farms. For more than one century cattle and swine breeding and high quality food production (Parmigiano-Reggiano and “salami”) have been integrated in this traditional farming system characterized by a dominant rotational role of grassland and a high level of agri-ecological stabilization. The schematic diagram in Figure 4 describes the system’s internal relationships. Excessive livestock concentrations, especially for swine breeding, derived from intensification processes in action (Figure 3) can be detrimental for the preservation of this farming system.

On a long-term basis, high livestock concentrations in agricultural areas where the rotational role of grassland has been substantially reduced can lead to severe risk of water pollution. The load of

livestock related to the rotational role of grassland and meadows can be considered as a critical parameter for the assessment of the environmental risk connected to agriculture intensification in the Po plain.

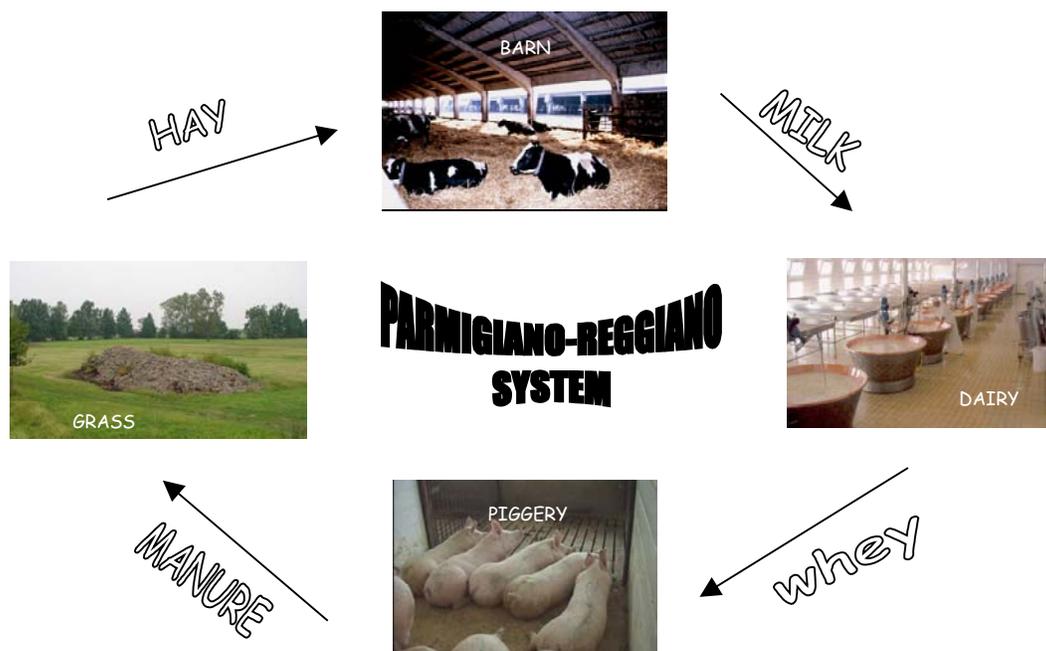


Figure 4. Relations and integration in the “Parmigiano-Reggiano” farming system.

The quantitative estimate on a spatial basis of this relationship - the ratio of tons of live weight to the area of leys and meadows- can be used for the assessment of the environmental impact of agricultural systems. The ratio could be compared in a GIS context with environmental variables characterizing agro-ecosystems vulnerability, such as soil characteristics and hydrogeological spatial data.

This parameter can also be considered an indication of the degree of farming systems intensification in the Parmigiano-Reggiano zone, since swine breeding unconnected to cattle breeding (i.e. independent of the “Parmigiano-Reggiano system”) tends to reduce the rotational role of grassland and to promote corn monoculture, more suited in the short term for excess nitrogen utilization but more susceptible to nitrate leaching (lack of winter cover), as well as to the loss of soil fertility on a long term basis.

Figure 5 shows, for each community in the study area, the live weight (tons) of cattle and swine per hectare of total agricultural area (ISTAT, 2002); whereas, in Figure 6, the live weight per hectare of grassland and meadows, as estimated from Landsat TM 1999 data, is reported. The

Reggio Emilia province showed the highest levels of livestock concentrations per unit of total agricultural area (Figure 5) derived mainly from intensive swine breeding (Figure 2).

As shown in Figure 6, the lowest values of livestock concentrations per unit area of grassland and meadows have been found in the Parma plain because of the major rotational role of grassland and the importance of haymaking in this farming system (i.e. the “Parmigiano-Reggiano system”). In spite of the high intensification level of swine breeding (Figure 2) low values have also been found for most of the Reggio Emilia province. In this area intensive swine breeding has been generally integrated in the Parmigiano-Reggiano farming system and the rotational role of grassland has been maintained; agricultural practices have to cope with N and P surpluses but the agri-ecological stabilization action of grassland is preserved. For the north-eastern part of the Reggio Emilia province, however, a spatially correlated tendency to intensification, indicative of the disconnection between swine breeding and cattle breeding is visible in Figure 6.

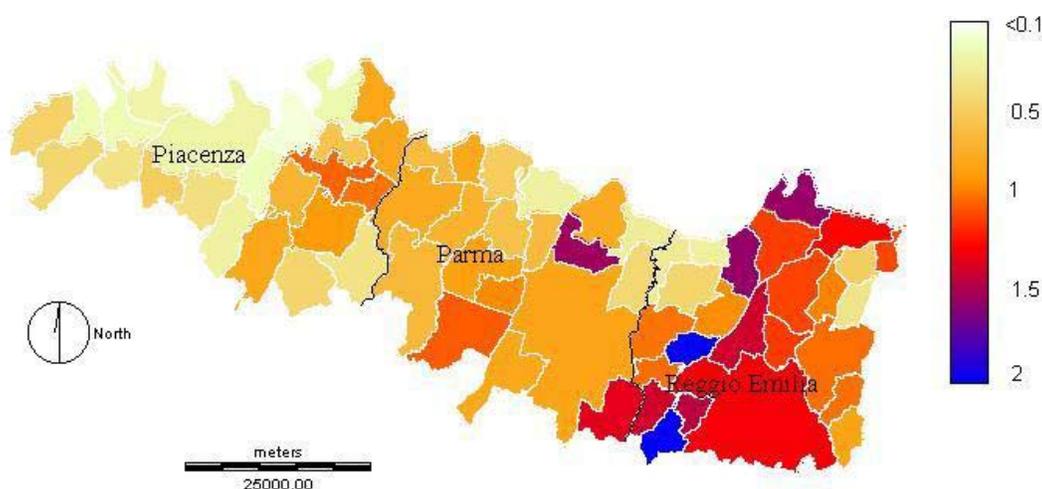


Figure 5. Live weight (tons) of cattle and swine per hectare of total agricultural area for districts of the three provinces (National Agricultural Census 2000).

As appreciable in Figure 6, some communes of the Piacenza Province (Cortemaggiore, Fiorenzuola and San Pietro in Cerro), not included in the Parmigiano-Reggiano production area, showed local critical intensification levels (i.e. the highest livestock concentrations per unit area of grassland in the study area) with high livestock concentrations, mainly derived from swine breeding, and a poor presence of grassland and meadows in rotation.

In these areas -- although we feel this holds for many other farming systems in the Po plain -- surplus nutrients derived from intensive swine breeding is accompanied by the intensification of crop cycles with corn (for grain and silage) and industrial crops (sugarbeet, tomato, soybean, pea) are replacing grassland in the rotations.

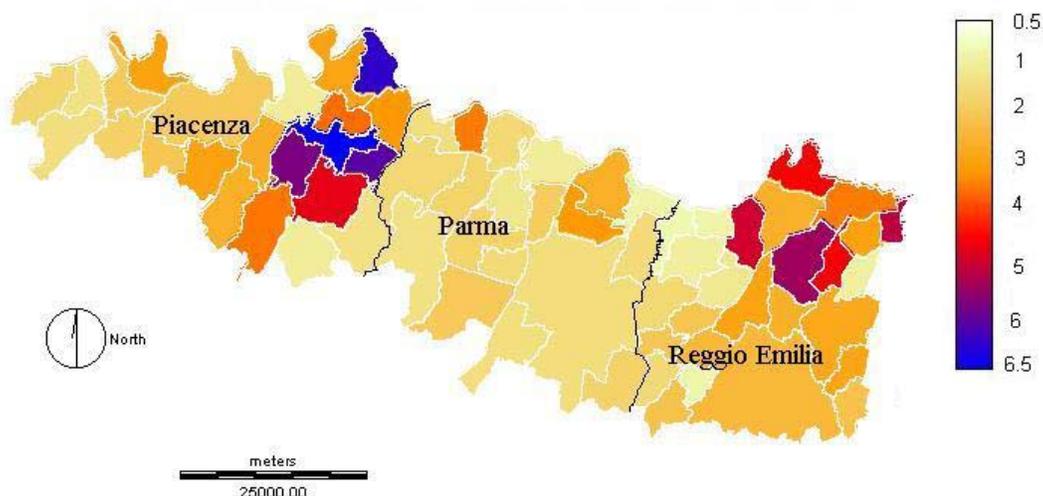


Figure 6. Live weight (tons) of cattle and swine (National Agricultural Census 2000) per hectare of grassland and meadows, as estimated from Landsat TM 1999 for districts of the three provinces.

Nutrient surpluses deriving from intensive swine breeding, intensive tillage cycles and the generalized lack of winter vegetation cover contribute to agri-ecological destabilization (decrease of soil fertility) and to the environmental impact of these farming systems.

As can be deduced by the slight increase of the rotational presence of grassland and decrease of livestock concentrations in the considered period, the typical farming system is being maintained in the Parmigiano-Reggiano production area. Nevertheless, this farming system is being affected in areas specialized for swine breeding - i.e. the Reggio Emilia Province – by swine breeding intensification associated with dairy enlargement. This tendency, driven by the need for cost reduction, could be detrimental for two relevant peculiarities of the Parmigiano- Reggiano Farming system: the high quality of food products (cheese and salami) and environmental compatibility.

Specific measures should be adopted in this area through agricultural policies to counteract this tendency and protect this typical farming system.

CONCLUSION

A GIS multi-temporal analysis of the rotational importance of grassland, obtained by remote sensing, and livestock concentrations conducted on farming systems of an area of the Po plain, highly specialized for dairy and “salami” products, has revealed some local critical level of farming intensification. On a long-term basis, such tendency toward breeding intensification could be detrimental to the environment, especially where the rotational role of grassland has not been preserved.

However, the existence of specific regulations for milk production for the Parmigiano-Reggiano, including the ban on the feeding of corn silage, has been a key factor for maintaining a sustainable farming system in the area of origin of the typical cheese. Grassland, haymaking, dairy production, swine breeding and swine manure utilization are the basis of the Parmigiano-Reggiano farming system, a highly integrated, environmentally compatible system characterized by high quality food products. In order to preserve this farming system, agricultural policy measures should address the limitation of livestock concentrations and promote food quality and environmental sustainability.

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