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## PROCEEDINGS


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# The utilisation of a geographical information system (GIS) for the valorisation of typical products from marginal areas

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**Abstract**

The economy of marginal areas is frequently compromised by the inadequacy of the transport system, the lack of co-operation between farms, and by the insufficient distribution of their typical products, whose valorisation may be a factor of growth for lands that, due to orographical and geographical handicaps, are often delayed in their economic development. In those areas the problem that more frequently arises is difficulty in planning land development due to the lack of or poor knowledge and classification of all possible information, together with the inadequate capability to get new information and possibility to simultaneously analyse many data.

From this point of view, the use of a Geographical Information System (GIS) appears to be a very useful tool because it allows matching information of geographical level (terrain height, gradient, slope orientation, soil utilisation, structures and infra-structures etc.) with pasture characteristics (pasture aromatic herbs, grass percent coverage, nutritional values, etc.).

In this paper, a GIS and image processing method was employed for an application in land use planning with reference to an internal area of Basilicata Region (Southern Italy), well known for its typical food products (sheep and goat cheese), with the aim to individuate new areas, that may be devoted to pasture, with the best characteristic and highest potential performance able to contribute for an increase of quantity and a standardisation of quality in production of Pecorino cheese.

The Geographical Information System that was implemented, through a crossing among its numerous informative levels, enabled us to obtain thematic maps with specific uses with the aim to locate areas destined to pasture. Through image processing, a different degree of importance both at any value of the single theme and to the different obtained themes has been attributed by weights, with particular care for pasture herbs and environmental load capacity of the different areas. The re-sampling of these informative level led to a final new thematic map named "Pasturage capability map" where areas with higher productive capabilities and with the best botanical characteristic are highlighted.

**Keywords:** GIS, typical products, marginal areas

# 1 Introduction

Sheep and goat raising plays a major role in animal breeding in Italy, not only in terms of economic weight of production but also of the related social aspects. Ewe's and goat milk products greatly differ in their characteristics - often original indeed – and their diversity is closely linked to the peculiarities of the growing areas and the production techniques in many cases related to old and consolidated traditions. In Basilicata region (Figure 1), in particular, most of cropping and livestock farms are located in mountain areas. On one hand, this further aggravates the problem of marketing, on the other hand, emphasises the different characteristics of production.

The GIS (*Geographic Information System*) is a support tool increasingly applied in agricultural and forest land, for its analysis (Gomarasca, 1995; Zucca et al., 1998; Manera et al., 2000), planning (Brunschwig et al., 2000; Coulter et al., 2000) and management (Wade et al.1998; Weber et al. 2001), and for the development of forecast models to support decision-making programming processes (Ayala et al., 1999).

Through the use of GIS applications and image processing, this paper is aimed at identifying the main characteristics of the surfaces to be used for pasture by sheep and goat-raising farms producing Pecorino cheese in a study area situated north-west of the Province of Potenza. It covers 31 municipalities included in the specifications for the production of "*Pecorino cheese of Filiano*" where agriculture has been since long one of the major subsistence factors for the resident population.

# 2 Materials and methods

The objective of this work is to inventory, integrate and correlate through spatial overlay all the data useful for implementing a decision support system. This result was obtained by organising the operations into the following steps:

1. **Identification and filing of basic informative layers**:
    - administrative boundaries;
    - villages and towns;
    - road network;
    - geo-lithological data;
    - hydrological data;
    - altimetric data;
    - vegetational data;
    - temperature-rainfall data;
    - data on sheep-goat raising farms.

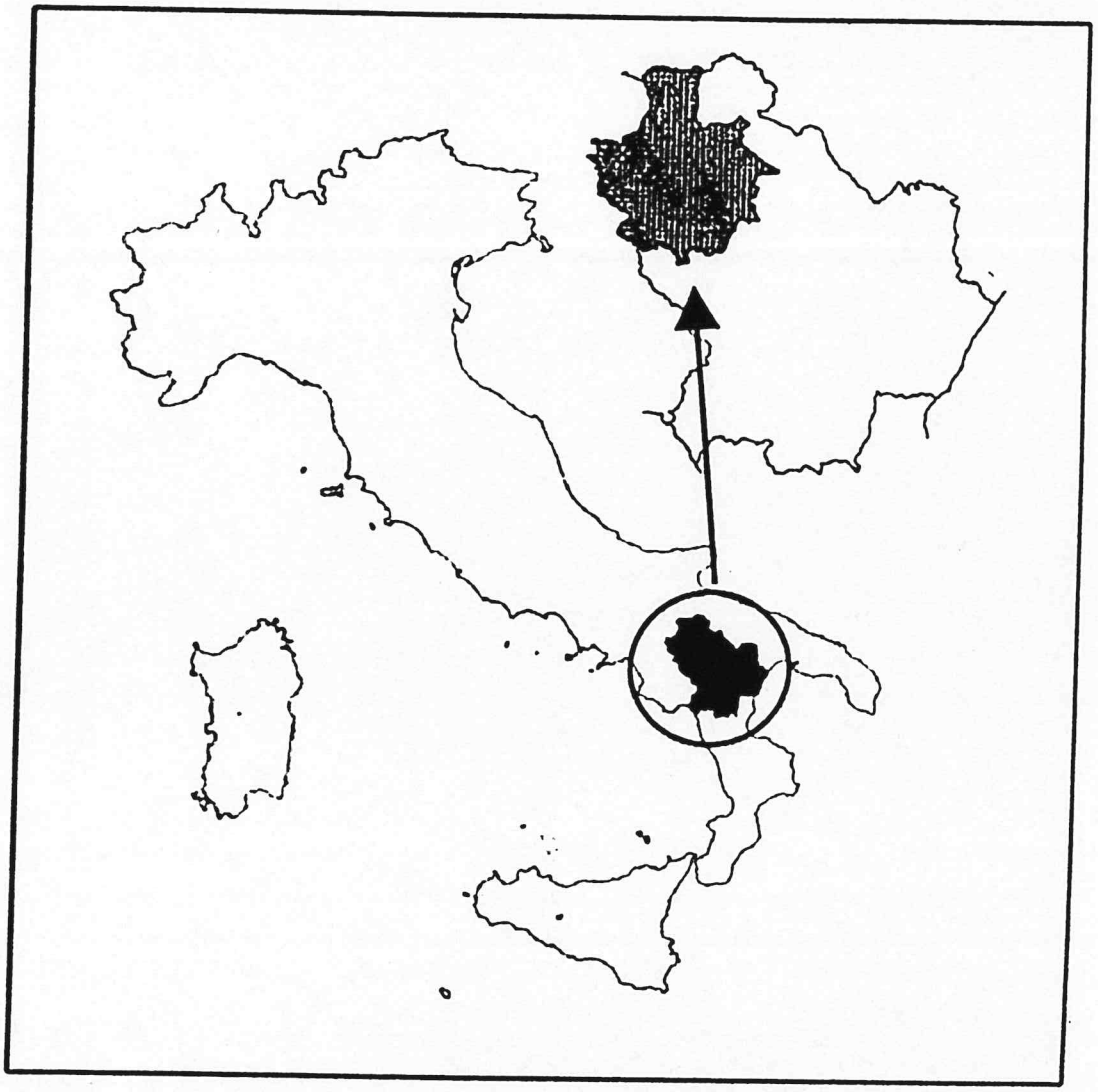
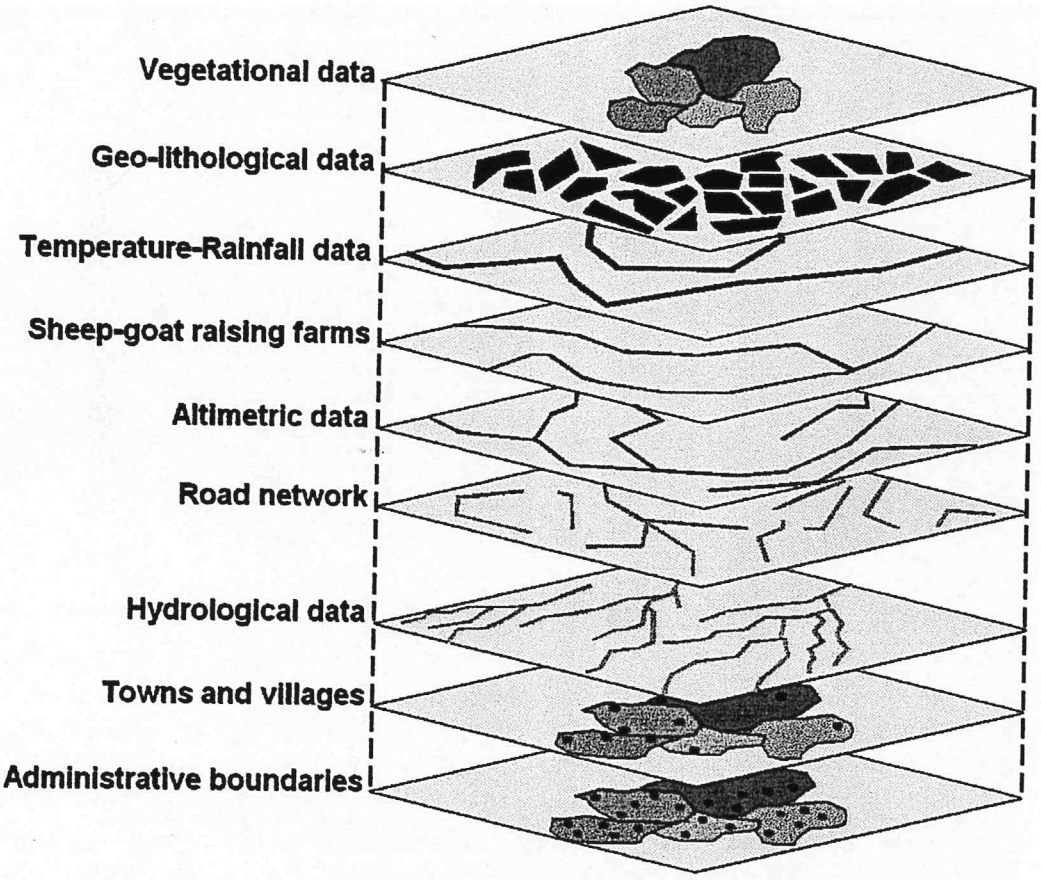


**Figure 1** — Basilicata Region and study area

## 2. Homogenisation and integration of basic informative layers

| LAYER | QUALITY |
|---|---|
| Elevation belt map (DEM – Digital Elevation Model)<br>Slope map<br>Exposure map | MORPHOLOGICAL |
| Permeability map<br>Temperature-rainfall map<br>Phyto-climatic belt map | CLIMATIC |
| Land use<br>Map of the areas presently used for pasture | VEGETATIONAL |
| Farm distribution map | ANIMAL HUSBANDRY |

## 3. Spatial overlay



The software tools used for filing, geo-referentiation and processing of basic and derived informative levels were:

| NAME | DESCRIPTION |
|---|---|
| Microstation 95 (Bentley) | CAD software used for making vector files |
| Descartes 6 (HMR) | Software for the georeferentiation of cartographic raster files |
| ArcView 3.2 (ESRI) | GIS software |
| 3D Analyst (ESRI) | Three-dimensional application software |
| Spatial analyst (ESRI) | Application software of raster processing |

Filing being completed, the data were first sampled, attributing a different importance degree ("weighing" operation of informative levels) both to every class of each single theme and to the different thematic levels obtained, in order to characterise the area of higher yield capability. For the attribution of weights, the influence of each single factor was preliminarily identified and weights were thus attributed to the different informative levels, quantifying them according to the estimated fodder yield.

The homogenisation and integration of data thus being completed, the layers were adequately processed to obtain a "*capability*" map, where the derived layers were gathered into distinct classes of "*quality*" subsequently used into new re-sampling operations where themes were processed through multiplicative algorithms (Manera et al., 2000). The result of simultaneous processing (Figure 2) of informative levels is a summarising map called **Grazing capability map**.

# 3 Results and discussion

The reliability of the new informative level was first checked by overlaying the capability map with the location of the sheep-goat raising farms. Overlay highlighted that the highest number of small raising farms falls within areas belonging to lower capability classes, whereas farms with a greater number of heads are located in areas identified as having a greater parametric grazing capability value (Figure 3).

Then, since the characteristics of more or less valuable pasture can be defined through agronomic and nutritional parameters, some of the said parameters were surveyed on a sample of farms falling within the study area in order to fully check the reliability of the proposed model.

These data were collected in collaboration with the *Istituto Sperimentale per la Zootecnia* of Bella (Potenza), and concerned both some sheep-goat raising farms and

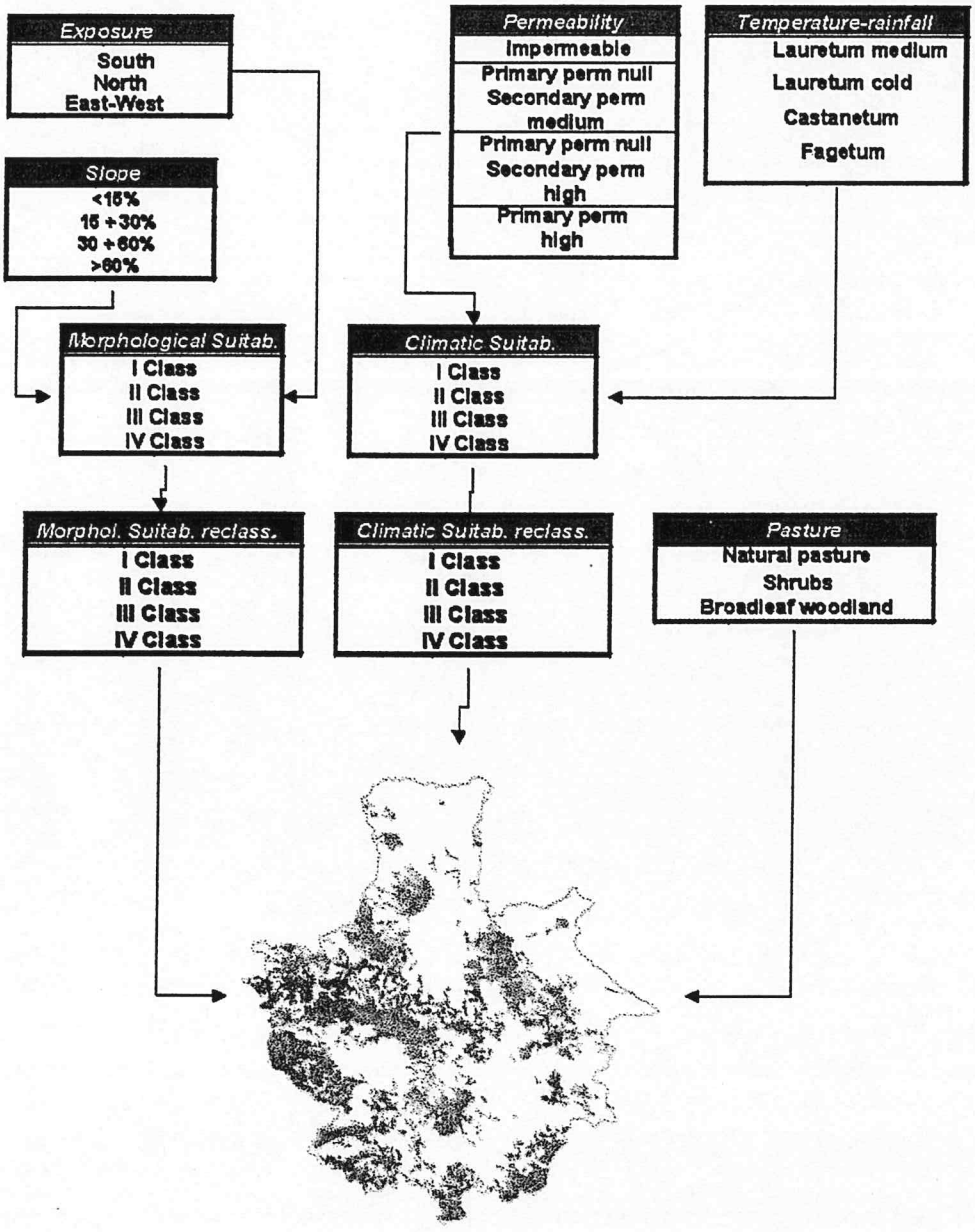



**Figure 2** — Summarising scheme and grazing capability map

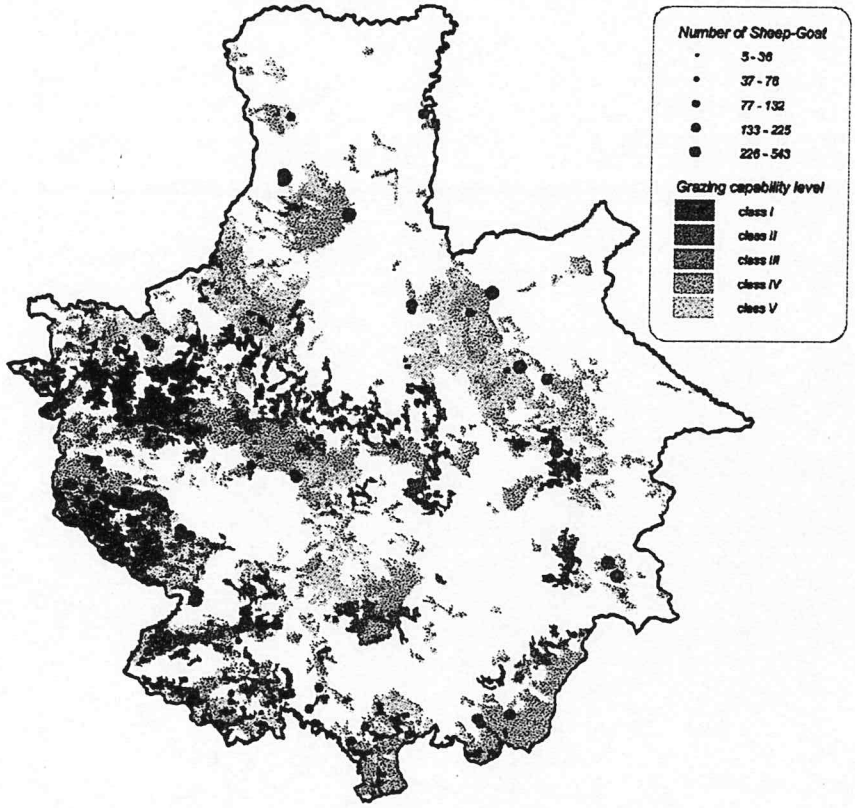



**Figure 3** — Grazing capability and position of sheep-goat raising farms

the corresponding pasture they use. In particular, the following data were collected:

| DATA | TYPE | DESCRIPTION | SIZE |
|---|---|---|---|
| AGRONOMIC (PASTURE) | QUALITATIVE | Dry matter (dm)<br>Raw proteins (rp)<br>Raw fibres (rf) | $Kg/m^2$<br>%dm<br>%dm |
| | QUANTITATIVE | Fodder Milk Unit | FMU / hectare |
| AGRO-FOOD (CHEESE-MAKING) | CURD | Curd size | m |
| | SCALDING | Scalding time | min |
| | SEASONING | N°days | days |
| ZOOTECHNIC (FARM) | BREED AND FEEDING | Race bred | |
| | | Crossbreed type | |
| | | Feeding | |

The agronomic data on pasture were grouped into five classes, in order to make them comparable with previous data treatments and overlay them with the grazing capability map.

Spatial overlay (Figure 4), showed that the values of the FMU parameter (equal to the energy contained in milk produced from an intake of 1 Kg of standard barley) increases for higher capability classes, thus confirming the better grazing suitability of those areas identified as having higher capability.

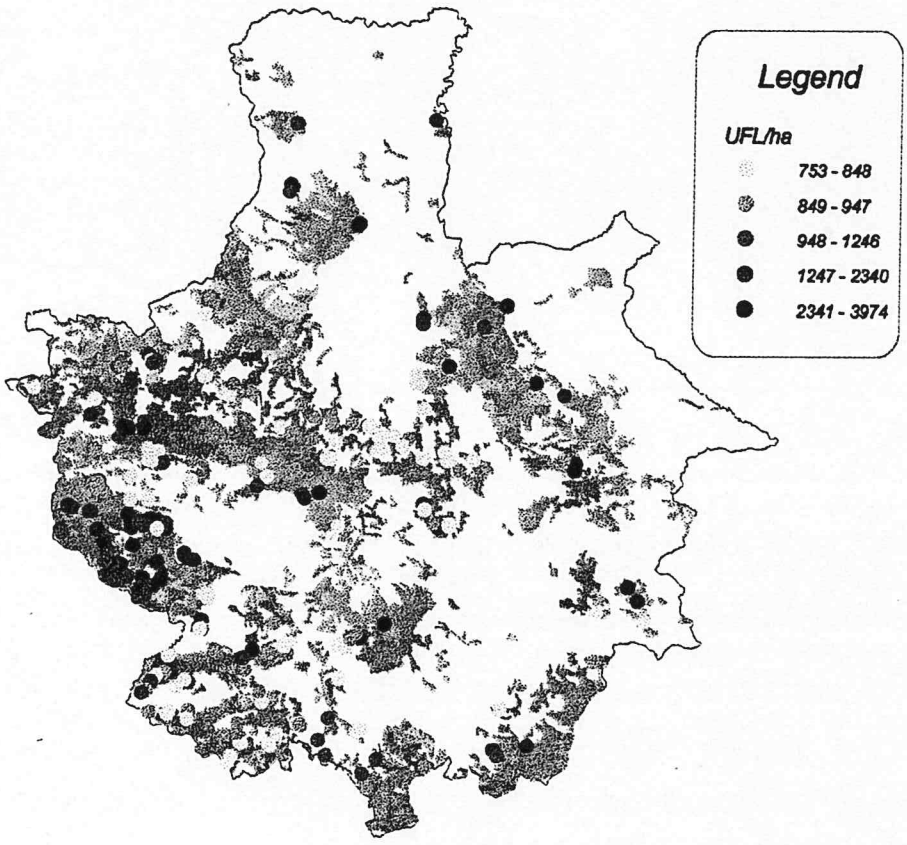
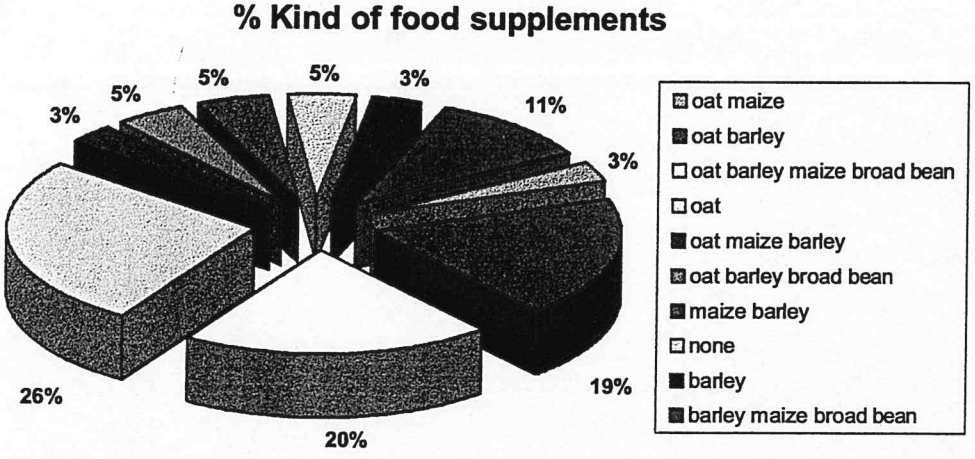



**Figure 4** — Spatial overlay

Such processing was made by considering the distribution of qualitative parameters individually (dm, rp, rf) and it showed that, as for the FMU, also for dry matter the maximum values coincide with the classes of higher capability, whereas this was not the case for the two other parameters (rp, rf). Such a difference is probably due to the variability of the species present in the grazing turf and, in particular, in the associations of legumes and grasses.

Finally, also considering that the qualitative/quantitative characteristics of pastures were surveyed in a special period of the vegetative season and that the results of processing could be thereby disturbed, the parameter of the food supplement supplied to herds to make up any nutritional deficit independently of the vegetative season were analysed too (Graph 1).

% distribution of farms per type of food supplement supplied




**Graph 1**: % distribution of farms per type of food supplement supplied

Through the data analysis, the relationship between the types of food supplements and grazing capability classes was pointed out (Table 1).

The wider diffusion of oat as food supplement, is because such fodder is more widely available in smaller farms with subsequently lesser heads, whereas in farms with a larger number of heads, combinations of oat and barley, maize and broad beans are more largely used.

Finally, based on the results obtained so far and considering that, on one hand, large agricultural surfaces are presently used for cereal growing and benefit from the economic compensation granted by the European Union that is supposed to cease in the near future and, on the other hand, pasture areas may increase due to the re-launching of Pecorino cheese, the "*propensity to grazing*" was assessed in the cereal-grown areas.

This further operation consisted in overlaying the grazing capability map (Figure 2) with the data relative to climatic and morphological suitability of areas classified as predominantly cereal growing in the land use map.

**Table 1** — Farm distribution per grazing capability class on the basis of food supplements supplied

| | V CLASS | IV CLASS | III CLASS | II CLASS | I CLASS | TOT |
|---|---|---|---|---|---|---|
| Oat | 6 | 6 | 0 | 5 | 0 | 17 |
| Oat, barley, maize, broad beans | 7 | 3 | 1 | 1 | 1 | 13 |
| Oat, barley | 4 | 1 | 1 | 3 | 3 | 12 |
| Barley, maize, broad bean | 0 | 4 | 0 | 3 | 0 | 7 |
| Oat, barley, broad bean | 0 | 2 | 1 | 0 | 0 | 3 |
| Maize, barley | 1 | 2 | 0 | 0 | 0 | 3 |
| No food supplement | 1 | 2 | 0 | 0 | 0 | 3 |
| Oat, maize | 0 | 0 | 0 | 2 | 0 | 2 |
| Oat, maize, barley | 1 | 0 | 0 | 1 | 0 | 2 |
| Barley | 2 | 0 | 0 | 0 | 0 | 2 |
| TOT | 22 | 20 | 3 | 15 | 4 | **64** |

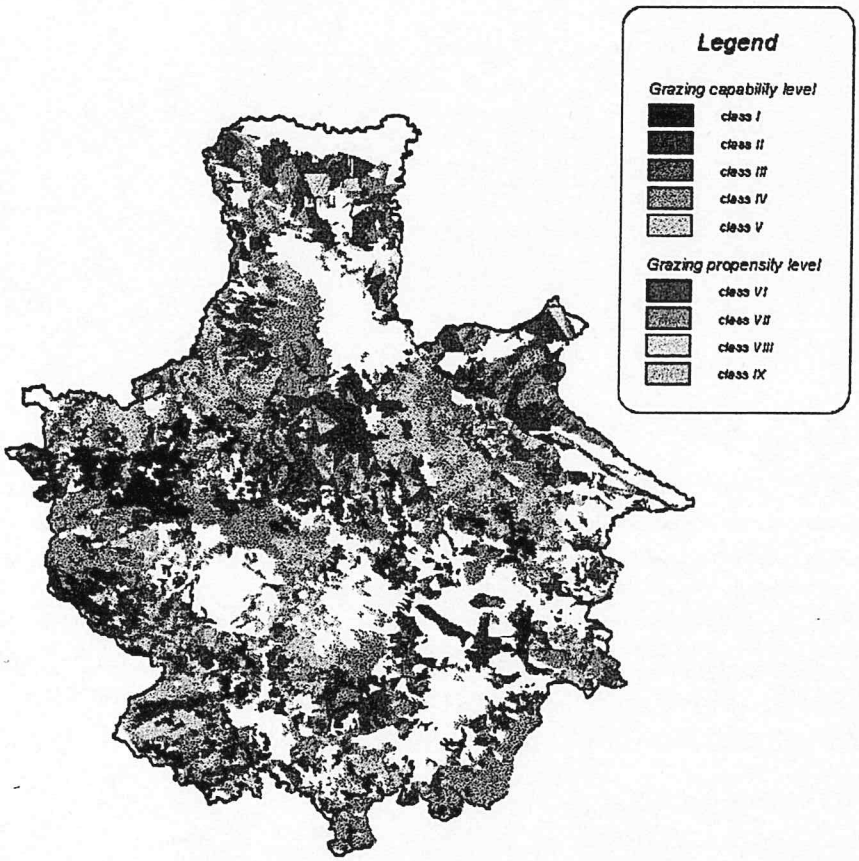



**Figure 5** — Grazing propensity map

The result of such further processing, reported in Figure 5 as "grazing propensity map", allowed highlighting additional capability classes thereby confirming again that most of the study area shows a marked grazing suitability.

# 4 Conclusions

The elaboration performed in this research work allowed producing a synthesis informative tool that reports the suitability of pasture for fodder production.

Additional and more detailed studies can be made by further integrating the qualitative/quantitative data of pastures and finding out additional agronomic parameters. Meanwhile, an analysis is being implemented on the possibility of optimising the infrastructure network of farms in view of the extremely important role it plays in marketing the products.

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