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De Blasi G., De Boni A., Roma R.

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AN APPLICATION OF "QUICK" CLUSTER ANALYSIS IN ORDER TO DETECT INTENSIVE/EXTENSIVE FARMING AREAS

GIUSEPPE DE BLASI, ANNALISA DE BONI AND ROCCO ROMA

Università Bari Dip. Studio società mediterranee
Via G. Amendola 165/a 70126 BARI
Tel.:390805443072, Fax:390805442527
deblasig@agr.uniba.it, a.deboni@agr.uniba.it, rocco.roma@agr.uniba.it

Introduction

One of the most distinctive characteristics of Apulian agriculture (Southern Italy) is the presence of "small farms" of less than two hectares of surface area. They represent more than 60% of the total number of farms and accupy about 10% of arable lands of the region. On the contrary of what happened in the rest of Italy and Europe between 1980 and 1990, the number of these farms did not decreased. Moreover, their share in the total regional income is in the same proportion (about 17%) with that generated from farms of bigger extension (Figure 1). It seems than smaller farms are as efficient as the bigger ones.

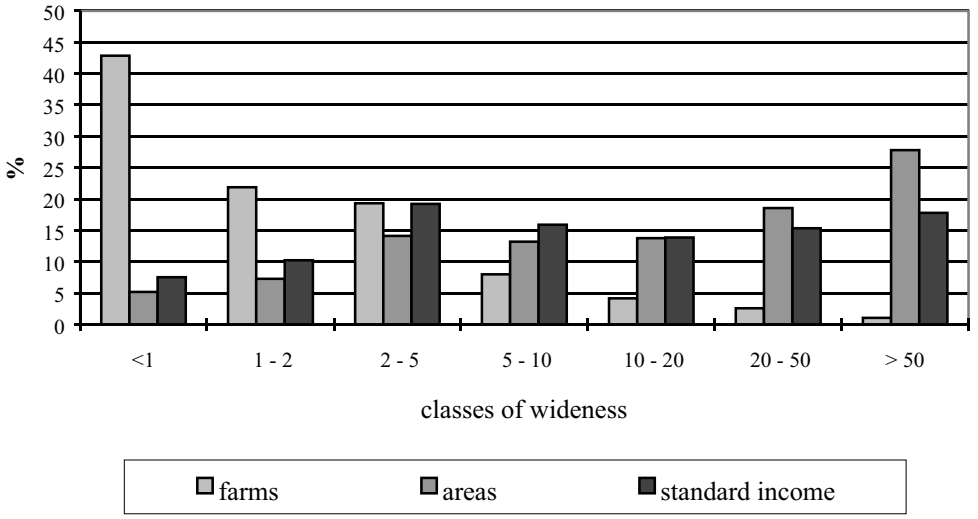

Figure 1. Distribution of farms, arable lands and standard income into classes of wideness.

Assuming that the good performance of smaller farms is generally connected with intensive farming, the aim of this study is to give a tool to the policy makers to locate sensitive areas. Moreover, it is important to establish that strategies and land use management technoloy linked to intensive farming in small farms can lead to an over-exploitation of natural resources and represent the risk of desertification.

In fact, one of the most important roles that public institutions have to play is to monitor the whole territory. The impact of anthropic activities on the environment, and in particular in the farmlands, is often dramatic. The public insitutions have to "read" within a set of variables the agronomical system and then try to integrate the findings of this "reading" with a set of socio-economical variables, in order to answer both questions: "what does impact?" and "who does impact?"

Materials and Methods

The starting basic concept is to examine land use of communal areas. This study is based on the *Territorial Specialisation Index* (IST) that shows the level of concentration/localisation of productive activities for a territorial unit smaller than the district where it belongs. The index is obtained applying to the elementary data matrix of areas invested with the *k* crops in the *n* territorial unit (UT) according to this formula:

$$(1) \quad \mathbf{IST} = \frac{\mathbf{a} - \mathbf{b}}{(1 - \mathbf{a}) * \mathbf{b} + (1 - \mathbf{b}) * \mathbf{a}} \qquad \text{where:}$$

a = ratio among the area of k_{ma} crop in the n_{ma} UT and the UAS[1] of UT;
b = ratio among the area of k_{ma} crop in the region and the UAS of the region.

The coefficient a is a composition ratio; its range will be:

$$(2) \qquad 0 \le a \le 1$$

Therefore, the two extreme cases represent either the complete absence of the crop in the UT (a = 0) or the fact that it completely fits the UAS (a = 1).

So IST will be: $-1 \le IST \le 1$ and we can have:

- $\mathbf{-1 \le IST \le 0}$ despecialisation of the crop in the UT;
- $\mathbf{IST = 0}$ the UT doesn't specialise the region for that crop;
- $\mathbf{0 \le IST \le 1}$ the UT presents a higher level of specialisation.

We obtained a matrix composed by 257 rows representing the observations and 9 columns, representing the crops[2]. We realised several *quick cluster analysis*[3] until were able to define 10 different clusters that we could rearrange in 3 areas:

1. *modest impact on environment:* presence of cereals, fodder crops and pastures;
2. *strong impact on environment*: (horticulture and olives); and
3. *medium impact on environment:* in which we find both types of crops.

[1] With the UAS (Usable Agricultural Surface) term we mean all areas covered with crops cultivations.
[2] The crops are those present in IV agricultural Census 1991 (the most scattered available data): cereals, hortives, fodder crops, pasture, olive, table and wine grape, fruit bearing and citrus.
[3] The *Quick cluster analysis* is a procedure of multivariate statistics in SPSSPC+

The same methodology has been applied to a different data-matrix that contains indexes relative to labour, irrigation, and agricultural machinery, all representative of a certain technical farming level. Three other additional areas were defined:

- *higher intensitivity level*: all indexes are high;
- *middle intensitivity level*: just one index high; and
- *lower intensitivity level:* all indexes are low.

Then, two different thematic maps of Apulia region were drawn and further elaboration was done in order to obtain a classification of communal areas divided in 9 classes, as shown in Figure 2.

		crops impact		
		H	M	L
Intensitivity level of technologies	H	HH	MH	LH
	M	HM	MM	LM
	L	HL*	ML	LL

Figure 2. Classes of susceptibility
Legend: H,H: high; M,M: middle; L,L: low; *: NO TOWN PRESENT

Result and Discussions

Based on the crop impact on territory, a first division allowed the identificaton of three main areas in Apulia as shown in Figure 3a:

- The largest one, characterised by specialisation for irrigated crops (vegetables, orchards, olives, and grapes) including more than half of Apulia Communes;
- A second area is marked out by the specialisation for non-irrigated crops (cereals, fodder crops and pastures); and
- Third area includes a mixture of both irrigated and non-irrigated crops.

The second zoning (Fig. 3b) provides a subdividion again in three zones that are homogeneous with regard to intensivity of implemented technologies. The most parts of the Region show low values for all the three indexes considered. Only 23 communes show high values of intensivity, instead, 24 communes have high values in only one index (either labour input or machinery equipment). An integrated reading of maps indicates four areas with different level of farming intensitivity (Fig 3c).

Areas called “extensive” include all communes with strong specialization for extensive crops (not irrigated) and, at the same time the lowest values of all the indexes of technological level. Areas called “intensive” are marked out by specialization for vegetables, orchards, olives, and grapes and by high values of index of labour input, machinery equipment and use of water.

Intermediate values of indexes studied allowed the identification of two areas called "zoo technical-mixed" and "fruit and vegetable-mixed". On a second step, the land structure of each of the above-described areas was studied.

The "extensive" area is characterised by the notable presence of "big farms", with large diffusion of cereals that occupy a small percentage of irrigated lands. Farms belonging to this area show the lowest unit income of the region.

The "intensive" area collects communes where "small farms" outnumber the other ones. If water is availaible, the growing area of vegetables and orchards could increase. Farms of this area reach a higher unit income, but also represent a higher risk of over-exploitation of natural resources because of over-cropping, over-grazing and excessive use of chemical inputs.

The area called "fruit and vegetable-mixed" is marked out by the presence of both intensive and extensive crops and by small farms. Water availability is low. With regard to unit income these farms are ranked as "intensive".

In last area, "zootechnical-mixed", all kinds of combinations are present. They include small and larg farms, and intensive/extensive crops. Forage crops and grazing herbs are especially present among extensive crops that allow the diffusion of almost exclusively of dairy cows.

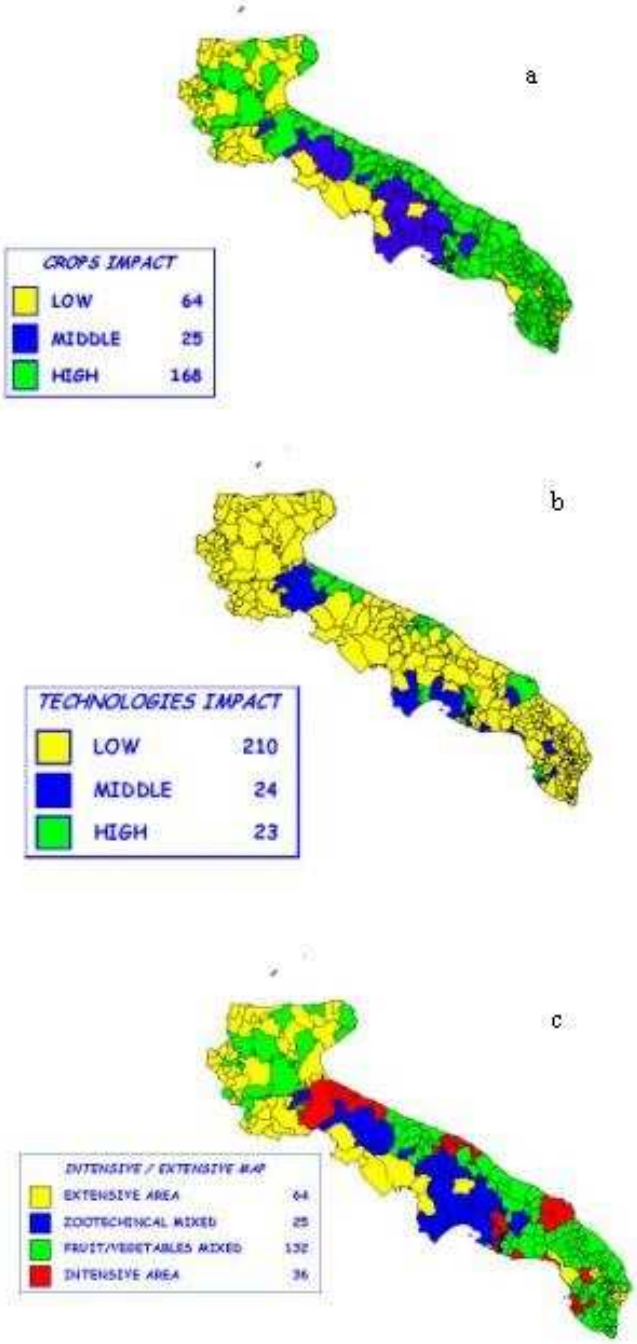

Figure 3. Obtained zoning

Extensive area

Communes classified as "extensive", represented within the yellow area in Fig 3c, include the areas of Appennino and sub-Appennino Dauno, Tavoliere delle Puglie, the pick of Gargano and the northeast area of the Murgia.

This area is characterised by the presence of large farms that represent 21% of total number of farms and occupy 80% of arable land. A small percentage of irrigated area (6%) and livestock farms (Fig.4) use an addition of 10% of the territory.

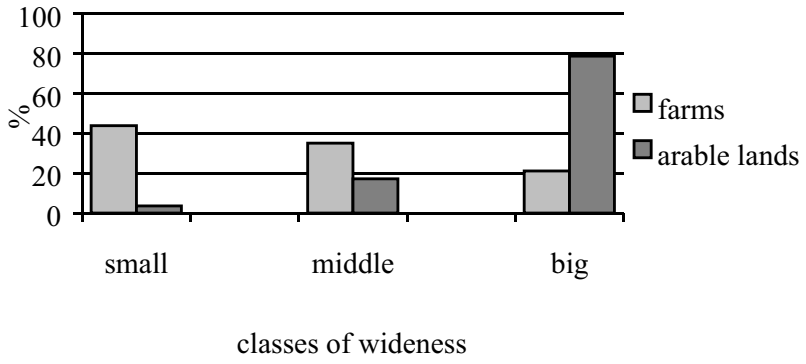

Figure 4. Estensive area. Percentage incidence of farms and arable lands by classes of wideness.

Figure 5 provides the distribution of crops by percentage area. As it could be seen, cereals occupy the largest area, followed by pastures, olive groves, fodder crops and vegetables.

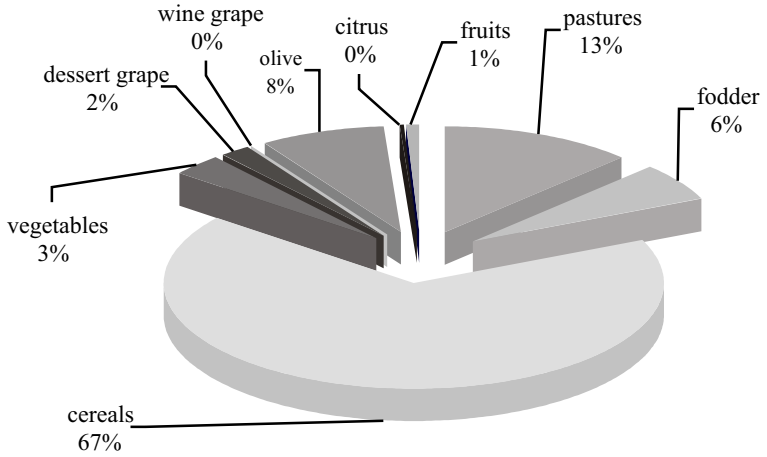

Figure 5. Extensive area. Percentual distribution of UAS by cultivations.

This croping pattern provides a mean standard income of the farms of this area of about 870 EURO/Ha, the lowest in comparison to the income of the farms of other areas. Moreover, livestock farms provide only a small contribution to the total income (8%) because of prevalence of goats and sheep breedings in this area.

Intensive area

Intensive area (red coloured in Fig. 3c) is composed by 4 groups of communes located along the Apulian coast arround 4 big centres: Cerignola, Bari, Brindisi and Taranto. These sub-areas are characterised by the strong presence of small farms (68% of total farms of the area), but they occupy only 18% of arable land.

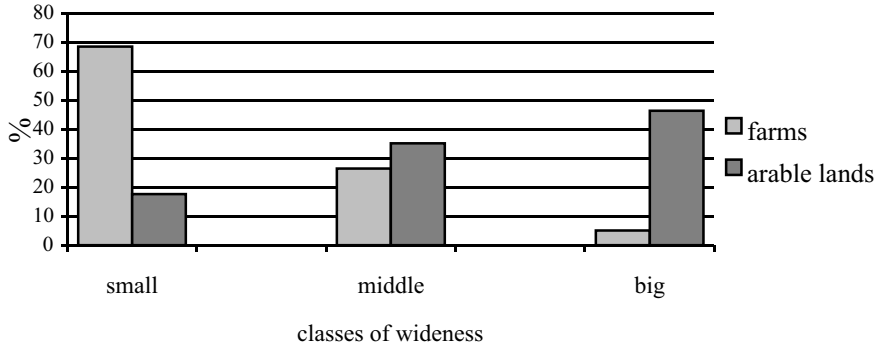

Figure 6. Intensive area. Percentage incidence of farms and arable land by classes of wideness.

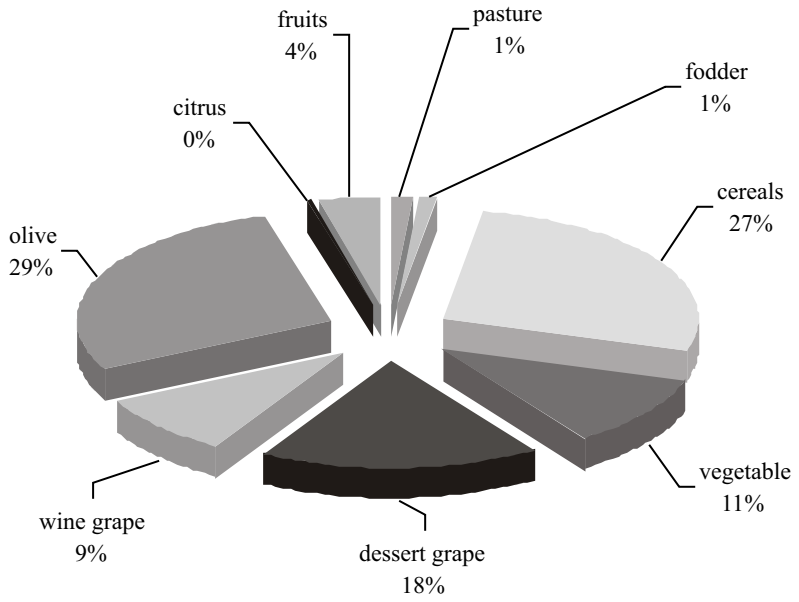

Figure 7. Intensive area. Percentual distribution of crops

The possibility to carry on activities like horticulture and grape-growing has allowed the farmers to obtain high incomes (2,000 EURO/ha), however these activities could have negative effects on the environment, because of their intensive use irrigation, fertilisers and chemical inputs.

Fruits and vegetables mixed areas

Areas called "fruit and vegetables mixed" (green coloured in the Fig. 3c) include communes specialised for fruit and vegetable production. In association are found also extensive crops (that represent 32% of arable land) and low-input land use type typically represented by olive groves (occupying 37% of arable land).

Similarly with the extensive area, this zone is marked by the high presence of small farms (69%), having an average size less than 1 ha. Large farms cover a smaller area. Even though the irrigated lands occupy only 12% of the territory they have great rilevance for the agricultural production.

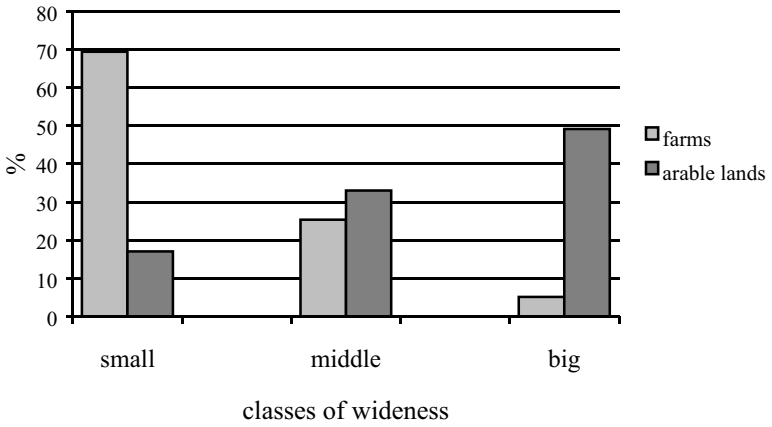

Figure 8. Fruits and vegetable mixed. Percentage incidence of farms and arable lands by classes of wideness.

It is necessary to specify that in this area crop variability is much larger compared to other zones. Figure 9 shows the crop distribution of "fruits and vegetables mixed" area.

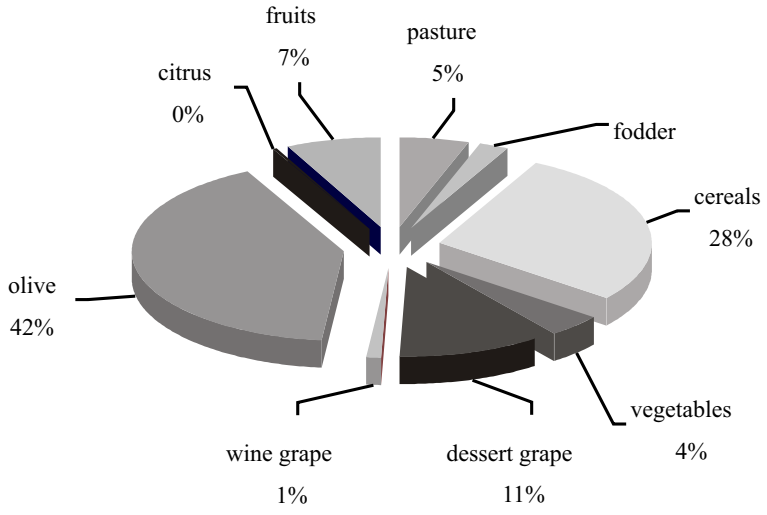

Figure 9. Fruits and vegetables mixed. Percentual distribution of crops

Communes of *Tavoliere delle Puglie* belong to "mixed" area because of the presence, in big farms of cereals and horticulture in the flat lands while on the hill smaller farms are present and the dominant land use pattern is represented by olives and wine grapes. The whole area between Bari and Brindisi is characterised by the presence of vegetables on the coast, and of olives and fruits in the inland.

Dominant land use in the *Peninsula Salentina* (southern Apulia) is characterised mainly by olives and vegetables that occupy large areas mixed with cereals. The presence of small farms still remains the rule. Livestock farms cover 4,3% of total farms and provide for only 2% to total income of the area.

Total income for hectare is 1,640 EURO. According to the economic value, the farms of this area are positioned somewhere in between the farms of "extensive" and "intensive" areas.

Zoothecnical-mixed area

Two sub-areas compose the last areas defined, the first placed in the nord-west of the city of Bari, and the second in "*Arco Ionico*" (sud-west of Apulia). Small farms are the most representatives occupying 66% of the total farms or 14% of the cropland. The big farms have an average of 33 hectares per farm.

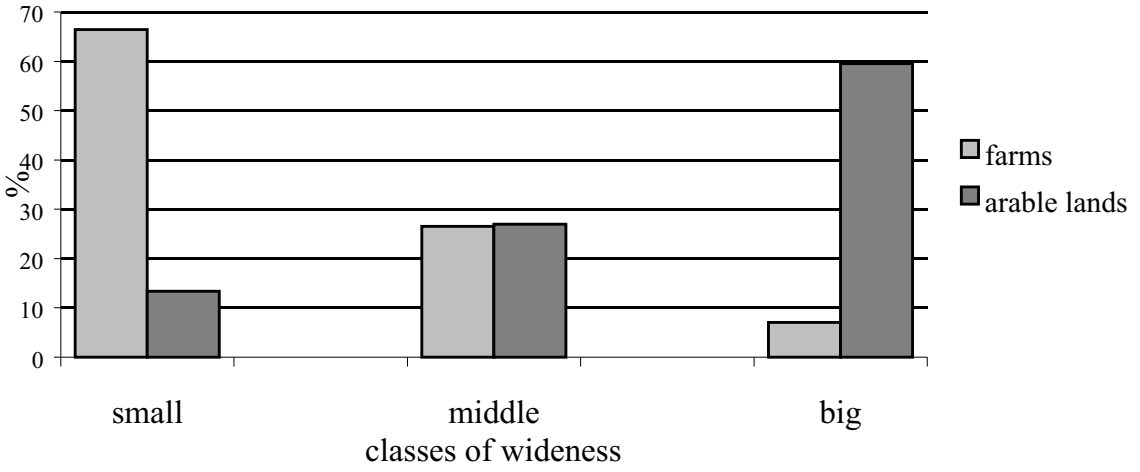

Figure 10. Zoothecnical-mixed area. Percentage incidence of farms and arable land by classes of wideness.

In the zootechnical-mixed area included are also zones specialised in olives (30%), orchards (9% of arable land), fresh grapes (9%), citrus (3%) and other extensive crops mainly represented by fodder crops (10%) (Figure 11). The presence of forage crops matches with the strong diffusion of livestock farms in southeast of Murgia. They represent less than 5% of the total number of farms but provide more than 7 % of total income of this area. The sub area called "*Arco Ionico*" shows a strong specialisation for cattle farms. In, fact exclusively dairy farms cover 78% of total amount of farms and provide 78% of income of livestock farms.

Conclusions

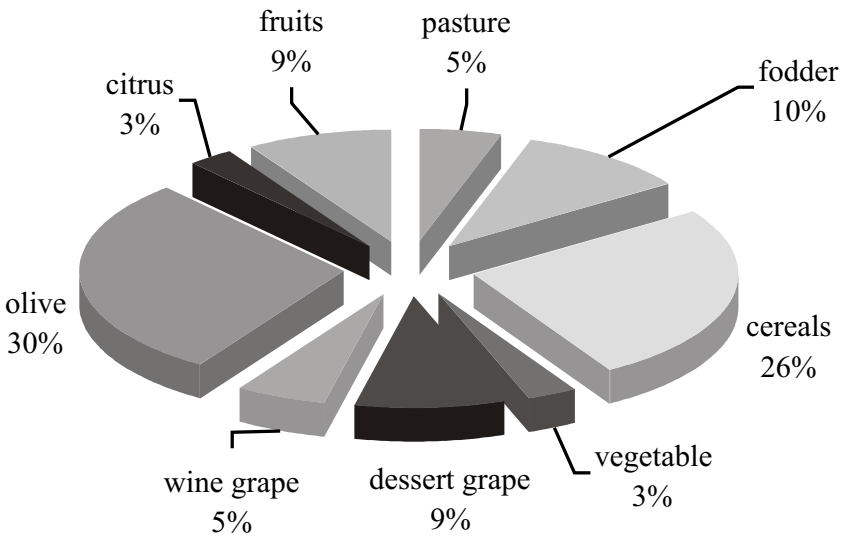

Figure 11. Zoothecnical-mixed area. Percentual distribution of crops

The thematic maps resulting from this study should not to be considered as an ultimate evaluation of environmental impact of farming, but only as preliminary steps for starting deeper analyses. The presence of small farms in areas of "high" and "middle" intensity requires special care. Small farms in Apulia show a better level of income if compared to those in the rest of the country. These good performances can be easily connected with cash crop farming, over-cropping and with an intensive use of land. However, legislation and policies should be oriented towards supporting the survival of small farms and assuring their sustainable existance.

Acknowledgements

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