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Role of forage legumes and constraints for forage legume seed production in Mediterranean Europe

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Summary - This paper briefly describes the role of pasture and forage legumes in the farming systems of Mediterranean Europe. The present situation of the annual and perennial forage legume seed market is analysed. The major constraints for forage legume seed production in southern Europe are discussed and possible solutions to face the low level of seed production of well-adapted Mediterranean varieties are proposed. The future perspectives of forage legumes uses and their seed production in relationship to the need for economic and environmental sustainability are also reported.

Key words: pasture legumes, forage legumes, seed market, seed production

Résumé - *Ce document décrit brièvement le rôle des légumineuses de fourrage et de pâture dans les systèmes fermiers de l'Europe méditerranéenne. On analyse la situation actuelle du marché de la semence des légumineuses de fourrage annuelles et pérennes. On étudie les contraintes majeures pour la production des semences des légumineuses de fourrage dans le sud de l'Europe. On propose des lignes de conduite pour pallier au manque de producion de variété méditerranéennes bien adaptées. Enfin, on rapporte les perspectives futures de l'utilisation des légumineuses de fourrage et sa production de semence en rapport à la demande d'aide économique et environnementale.*

Mots-clès: *légumineuses de pâture, légumineuses de fourrage, marchè des semences, production des semences*

Introduction

In this paper the role of forage legumes is discussed with particular reference on their seed production in the Mediterranean Europe (i.e.: Greece, Italy, Portugal, Spain and south France). Some data on Yugoslavia (Serbia and Montenegro) and Albania are also reported.

A wide range of forage legumes are currently used in Mediterranean Europe because of the extreme variability of the environmental conditions and farming systems. This paper deals only with the most relevant forage legumes traditionally grown in the Mediterranean area and for which a seed market exists.

In the 20th century, two contrasting situations characterised the rural societies of the Mediterranean Europe. The abandonment of marginal areas and the intensificated use of arable lands occurred in the more economically developed regions (e.g. South France, North Italy) while land overuse often associated with heavy grazing pressure was observed in the southern regions (e.g. Greece, South Spain and Sardinia). In Italy for example about 2 millions hectares were abandoned as a result of the post-war industrial revolution (Falcinelli *et al.*, 1995).

Forage legumes and farming systems

Animal production systems in Mediterranean Europe are dominated by small ruminants while cattle-based farming systems are not widely used. About 60% and 97% of the total number of sheep and goats respectively reared in the EU, are present in the Mediterranean area.

About 15 millions hectares of land are represented by native and improved pastures and permanent forage crops in the considered region. Native legumes, mainly annuals, are an important component of the ecosystem and production of the grassland. The species diversity of Mediterranean pastures can be high, despite of the effects of strong ecological factors such as summer drought and shallow soils. Bagella *et al.,* (in press) have identified over 150 herbaceous species in a 1 ha acid (pH 5.5) pasture of north-eastern Sardinia (Italy) including 32 annual and 1 perennial legumes.

The role of the legumes changes in relation to the forage system:

- *annual pasture legumes* are an important component of the extensive systems (agro-silvopastoral and agro-pastoral systems) used to improve low quality native pastures and to seed new pastures. Subterranean clover and annual medics are the main species utilized particularly due to their self-reseeding ability and grazing tolerance often under sub-optimal and variable environmental conditions. Because of the great success obtained in Australia by these species several studies and selection programs have been carried out by different European Mediterranean Research Institutions in the last 20 years.

In Spain (Gonzáles López, 1994) five subterranean clover varieties were selected and registered in 1985 (Orellana, Coria, Areces, Valmoreno, Gaitan) and two in 1989 (Zujaran and Cubillana). In Italy four varieties of subterranean clover have recently been selected by Piano and Pecetti (1997) (Antas, Campeda, Losa, Limbara) and a *Medicago polymorpha* L. variety named Anglona by Porqueddu *et al.* (1998). New varieties were also selected in Portugal (Davel, Romel) and France but problems related to seed multiplication have not permitted a wide diffusion of all these varieties.

- *annual forage legumes* are traditionally used mixed with winter cereals (oats, barley) and grasses (Italian ryegrass) for short-term forage crops, or in rotation with cereals in different kind of farming systems on arable lands. The main species utilized are *T. incarnatum* L., *T. alexandrinum* L., *Vicia sativa* L. while *T. resupinatum* L., *V. villosa* Roth. and *Lathyrus* sp are of secondary importance. The annual forage crops are grazed or mowed for hay. In many cases use is flexible and mixed with winter grazing and spring hay production. The recent imposition applied to some species to be commercialized only means of certified varieties, has increased local seed production (e.g. *T. alexandrinum:* Italy is now exporting seed while before it was imported from Egypt). National subsidies in the 70's increased cultivation of *V. sativa* in Spain where it represents the second main forage crop after alfalfa, covering about 25% of the total surface cultivated with forage legumes, mostly on rainfed conditions,.

- *perennial legumes* are used particularly for meadows in specialized fodder crop systems. They are found in areas suitable for cultivation, a part of which is often irrigated. Dairy cow farming is prevalent with high stocking rate and agronomic inputs while the feeding system is mainly based on hay and silage rather than grazing. Double cropping of Italian ryegrass followed by maize or sorghum for silage in rotation with alfalfa is common. *Medicago sativa* L. represents the main forage crop, covering a total surface of about 1,5 million of hectares in Mediterranean Europe. However, in Italy, for example, alfalfa lost 50% of its hectarage in the last 50 years while the opposite was true in Albania where with the transition to the market economy the surface of alfalfa has doubled (from 50,000 to 100,000 ha) since 1990 (Boka *et al.*, 1999). Alfalfa is utilized in pure stands as hay or green, or dehydrated forage. However it is often grazed or under mixed utilization. It lasts about 3-4 years before a rotational crop is

grown. Alfalfa is also sown mixed with perennial grasses such as perennial ryegrass and cocksfoot and tall fescue. In Spain the most largely used alfalfa is the ecotype Aragon (70% of the alfalfa seed market) while in Italy it is the ecotype Romagnolo. In France varieties obtained by simple selection of local types are widely utilized (Magali and Polder). The diffusion of ecotypes is related to the low results achieved by forage breeding in Mediterranean Europe. To encourage the exploitation of the potential of alfalfa ecotypes, a law will come into force in 2002 in Italy prohibiting seed commercialization of ecotypes. The aim is to promote improvement of the varieties and to save the valuable alfalfa germplasm still cultivated in several regions of the country (Falcinelli and Martiniello, 1998).

Trifolium repens L. is used for grazing, especially on acid soils but only under irrigation and most of the utilized seed is represented by varieties not selected for the Mediterranean environments and imported from New Zealand, the USA and Denmark. *T. pratense* L. and *Lotus corniculatus* L. have almost disappeared although in the past they were widespread in hilly areas without irrigation. The same is also true for *Hedysarum coronarium* L. and *Onobrychis spp.* which were traditional components of the farming systems (in rotation with cereals) located on calcareous soils under rainfed conditions (e.g. sulla in Baleari Islands and Sicily, sainfoin in the Appenines of Central Italy) but there is renewed interest in them. This is particularly true for sulla due to several interesting traits, such as summer dormancy, high forage quality (level of condensed tannin), grazing tolerance and vegetative propagation associated with self-reseeding ability (Sulas *et al.*, 1999) which are stimulating interest in its utilization and the seed production.

Present situation of forage legume seed industry

The European forage seed production is concentrated in North Europe mainly in Denmark, the Netherlands, Great Britain and France while forage seed import is relevant in Mediterranean Europe. The organization of seed production is far from satisfactory and often the seed is a by-product of forage crops. Seed of most perennial legumes (alfalfa and sulla) is produced in Southern Europe, but the production is mainly based on ecotypes and local populations even if in recent years the seed production of certified varieties has increased.

A total of about 10,000 t of alfalfa seed are produced in Mediterranean Europe covering most of the local demand (table 1 and 2). Alfalfa represents the main forage crop in Yugoslavia also (Serbia and Montenegro) and about 1,500 t of seed is produced of which part (500 t) is exported (Radenovic, 1995).

Table 1 – Certificated seed production (t) of forage legumes in the Mediterranean Europe and subsidies (Euro kg^{-1}) for the certificated seed production of forage legumes in the European Union.

Legume species	GR	E	F	I	P	subsidies
H. coronarium	-	-	-	250	-	0.365
M. sativa (ecotypes)	-	830	-	2,200	-	0.221
M. sativa (varieties)	400	120	4,500	1,300	5	0.366
O. viciifolia	-	-	2	-	-	0.200
T. alexandrinum	10	-	2	1,400	-	0.458
T.incarnatum	-	-	320	750	-	0.458
T. pratense	-	-	1,200	50	-	0.535
T. repens	-	-	15	5	-	0.751
T. resupinatum	-	-	4	265	6	0.458
V. sativa	4,000	4,300	9,500	4,200	-	0.307
V. villosa	-	330	-	10	-	0.240

(Source: European Commission, 1999)

The production of well-adapted cultivars of pasture legumes for Mediterranean Europe is extremely low. It needs to be covered by import from Australia, New Zealand, Central- and North-Europe. Seed companies often commercialize cultivars adapted to temperate zones at low prices and concentrate their efforts on the commercialization of imported seed from elsewhere, packed, labeled, sometime mixed and then partially re-exported. As a result, little interest is devoted by the European agricultural policy to the Mediterranean pasture legumes and no official data on the seed demand of such species are available (e.g. subterranean clover).

For these reasons statistics concerning the seed market, particularly for the uncertified seed of typical Mediterranean pasture legumes (seed imported as animal feed and amenity is also included), are often difficult to find and unpredictable.

Table 2 - Seed demand (t) of forage legumes in the Mediterranean Europe (1997).

Legume species	GR	E	F	I	P
H. coronarium	-	15	-	210	1
M. sativa	100	3,200	3,000	7,500	20
O. viciifolia	-	90	300	550	-
T. alexandrinum	76	-	20	800	5
T.incarnatum	40*	-	190	1,100	15
T. pratense	-	90	1,000	250	14
T. repens	-	-	80	380	15
T. resupinatum	-	-	180	130	20
V. sativa	6,000	7,200	2,000	4,200	70
V. villosa	-	2,000	30	200	30

* total of annual fodder legumes (Source: European Commission, 1999)

Major constraints for forage legume seed production

The major constraints for the assessment of the highly valuable native genetic resources and the development of the seed industry in Mediterranean Europe which hinder the production of seed at competitive costs appears to be due to several intrinsic or structural links:

- the presence of a restricted and diversified demand (small markets and many species or varieties) in relationship to the different environmental agro-ecological areas to edaphic covering and climatic variations (arid, semi-arid, sub-humid, humid and irrigated areas) and the different farming systems;
- lack of importance given to the choice of variety. Farmers when buying forage seeds often do not exercise the same attention to the choice of the variety as they do for cereals and seed price is the chief driving force in this seed market.
- recent or undeveloped organization of forage seed production. In many Mediterranean regions the seed is locally produced and re-utilized by the farmers themselves;
- in the irrigated areas there are other competitive crops (horticulture, fruit plantations);
- national norms on registration and certification were instituited recently or later than North Europe (e.g. Italy for subterranean clover and burr medic);
- no clear legislation on forage seed trade: for example the commercialization of forage seed as animal feed is permitted and also the use of unknown mixtures which makes fraud easier ;
- EU agricultural policy which favours cereals (e.g. durum wheat) and oil crops (e.g. sunflower) of which their minimum income is about 500 Euros per ha of subsidies while low support is devoted to forage seed production (table 1).

As a consequence, a low amount of research funds were addressed to this topics. In agriculture, as well as in other sectors, the research was carried out mainly in the more developed areas with the aim of solving problems related to the main and more profitable crops and little interest in the problems of less favoured areas (Rivoira *et al.*, 1989).

Guidelines to face the lack of production of well-adapted Mediterranean cultivars

In all Mediterranean Europe the breeding activity on forage legumes has been until recently mainly carried out by public national institutions as well as seed multiplication (e.g. in Spain for the subterranean clover). The evaluation tests for the registration of new varieties and quality control of seed for certification are generally under direct public control. In agreement with what has been proposed by Lelievre and Mansat (1990) it is important to define long term common research aims that overcome the specific national interests according the following lines:

Research on genetic aspects and breeding activities

⇒ to choose some pilot species: e.g. *M. sativa* and *H. coronarium* between perennials, *T. subterraneum* and *M. polymorpha* among annuals.

⇒ to determine the agronomic selection criteria for the sustainability, particularly for pasture species to be used in rainfed condition on sub-optimal conditions and extra productive uses (Roggero & Porqueddu, 1999).

⇒ to evaluate the materials under selection or already selected in many locations and define a common management of trials and seed register.

⇒ to collect, to characterize and conserve *(in sutu* and *ex situ)* the local germplasm.

Research on seed production

⇒ to create a demand of selected varieties demonstrating that the varieties improve quantity and quality of production.

⇒ to organize a structure to multiply the seed, establishing research units specialized in seed production at local level.

⇒ to promote a permanent relationship between researchers, seed companies and farmer-seed producers.

In this field, encouraging scientific and technical results were achieved on white clover and burr medic seed production in a three year-common research project financed by the EU involving French, Italian, Portuguese and UK teams (Lelievre *et al.*, 1995).

Research on the physiological basis of seed production

⇒ to define the main factors affecting or limiting seed production:

- influence of environmental factors on floral induction;
- influence of water supply on reproductive phases;
- effects of high temperature on seed quality;
- vegetative/reproductive balance.

Research in forage seed production should be focused on improving the efficency of the reproductive system rather than its size, fully utilizing the potential yields which are always enormous (Lorenzetti and Rosellini, 1999).

Future perspectives

Two of the major issues of Barcelona Declaration, adopted at the Euro-Mediterranean Conference held in November 1995, are aimed at the promotion of environment-friendly agriculture and the support of production diversification. As suggested by Delgado (1997) it should be necessary to follow different strategies of intervention for the extensive (selection of materials with low costs of establishment and management) and the intensive systems

(selection of new materials capable of utilising fertiliser better, reducing chemical control, adapted for forage conservation and high quality). The rationalisation of farming systems with high environmental sustainability and new trends in the EU policies in terms of reduced subsidies offer new opportunities for the use of forage legumes in pure stands or mixtures. An example of the evolution of the traditional cereal farming system is reported by Fois *et al.* (1996). They obtained more regular distribution of forage production in quantitative and qualitative terms during the year and better animal performances and economic results within two alternative systems for dairy sheep, the first based on a rotation of short term forage crop and a self-regenerating grass-legume pasture and the second including pure stands of perennials species (*H. coronarium* and *D. glomerata*) on 20% of the surface.

An increasing interest is being given to traditional techniques such as crop rotation, N fixation by legume crops and green manuring to be re-assessed as biological inputs to organic production systems. For example, the introduction of subterranean clover as living mulch into conventional cropping systems (e.g. rotation winter cereal-sunflower) was found to have very positive results in terms of weed control and N-fixation in Central Italy with low negative effect on grain yield (Campiglia and Caporali, 1994). These kinds of systems lead to higher quality and consequently to an increase in the value of the products and have positive effects on the sustainability of farming systems located in the less favoured areas. Regarding organic farming systems, leaving aside the questionable scientific basis, it appears very difficult to respect the EU norm which states that only organic seed can be used in these farms from 2003 particularly for the annual pasture legumes imported from extra-european countries.

The increasing attention in low-input oriented agriculture in Mediterranean Europe involves the use of forage crops also for extra-productive purposes. Forage legumes have been shown to be adapted for erosion control, soil organic matter improvement in vineyards and orchards, fuel-break maintenance, mining site rehabilitation and multiple land use. In this field a multidisciplinary (including agronomists, breeders and soil scientists) National research programme financed by the Italian Agriculture Ministry is being carried out with the aim of selecting well adapted varieties to be used in these kinds of systems and set up new techniques at different levels of intensification for herbage covering for more sustainable cropping systems.

Pilot actions involving private local seed companies should be conducted to evaluate the already existing selected and well-adapted material, thus improving the connection between public and private institutions to promote the production chain. Collaborative network between public institutions, where the selection is carried out, and private seed companies for the multiplication on a large scale should be encouraged by local administrations. As shown by several studies the production of high quality seed, typical of northern European varieties, is also profitable in the new irrigated lands under optimal environmental conditions during seed setting (Roggero *et al.*, 1995).

Strong interest should be directed to studying low cost seed production using conventional crop machineries instead of vacuum harvesters utilized for subterranean clover and annual medics which are slow and leave the soil exposed to erosion (Nutt and Loi, 1999). In an European market with surplus productions, the forage seed production can be considered an interesting alternative activity and should be promoted. International institutions (e.g. EU, FAO) should have important responsibilities to create and support common research programs improving scientific exchanges among teams operating in the different Mediterranean countries.

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