FOURTH EUROPEAN SYMPOSIUM
ON EUROPEAN FARMING & RURAL SYSTEMS

Research and Extension into the Next Millennium
Environmental, Agricultural & Socio-economic Issues

Workshop : Contribution of Sciences to the Development of Farming Systems

April 3 to 7, 2000 Volos - Greece

DROUGHT RESISTANT PERENNIAL FORAGES FOR DESIRABLE ECOLOGICAL FARMING SYSTEMS IN GREECE

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SUMMARY

Perennial forage species**,** grown under rain fed conditions, have a great potentiality for supporting extensive livestock production systems in dry areas provided that the right species and the right varieties are used. Research on this subject, is world-wide limited. Some small projects have been carried out in Greece during the last two decades.

Twenty to thirty years ago there were not any Greek land races or bred varieties of perennial forages except those of *Medicago sativa*. Tested foreign-bred varieties have been proved no good producers, as they had not the ability to survive in long intense summer drought. Collecting wild or seminatural, indigenous forage germ-plasm started in Greece in 1977. Part of this germ-plasm has been evaluated for drought resistance, persistence and forage productivity, under rain-fed conditions. Large variability was found into *Medicago sativa,* (alfalfa) *Medicago arborea, Dactylis glomerata,* (cocksfoot) *Festuca arundinacea,* (tall fescue) *Lolium perenne, Poterium sanquisorba minor and Hedysarum coronarium.* Bred varieties of these species have been created by selection and the best of them have been registered in the national list of varieties. A considerable perennial forages germ-plasm collection is maintained in Larissa and Thessaloniki including more than 1,600 accessions, 16 % bred varieties, 45 % breeders lines, 3% land races, 36 % wild or seminatural populations.

New Greek varieties of perennial forages could be used, as pure stand or as mixtures, to expand perennial forages in arid or semi-arid areas. Drought resistant alfalfa v. *Hyliki, Hypaty, Dolichi, M. arborea* v. *Naxos, P. saquisorba* v. *Amphiklia* and *H. coronarium* v. *Aegean Sea* could be used successfully under rain fed conditions for supporting extensive livestock production systems and for environment conservation. Other perennial species should also used for the same purposes but only in cooler regions. Their potentialities have not been explored yet. More, co-ordinated research is needed on this complicated subject.

Protecting against soil erosion and wild fires, abandoned soil reclamation, saving water and energy, improving native fauna, soil fertility and aesthetic situations are the environmental benefits. Reducing concentrates consumption in animal feeding, smoothing animal production, increasing farmers income in disadvantaged regions, stabilisation of rural population in problematic areas, improving cereals rotation and soil fertility, fitting at new GATT and CAP, are the social and economic benefits.

A. INTRODUCTION

Environment and land degradation, natural or induced by humans, is a universal problem in continuing process in some cases. This phenomenon is frequent in Mediterranean countries because of the dry-hot climatic conditions and the intensive land use applied from ancient time. Abandoned, marginal slopping soils are in abundance, facing in some cases an increasing risk of desertification. Drought resistant perennial forages have a great potentiality for these abandoned soils reclamation and for supporting extensive livestock production systems. Such desirable ecological farming systems should be in first priority in Greece and in other EU Mediterranean countries.

Climatic conditions in Greece are large diversified because of the surrounding sea and the quick alternation from mountains to valleys or from plains to hills. Mean annual rainfall is ranging from 300 mm to higher than 1000 mm. Mean temperature in January is ranging from 1º to 12º C, in July from 23º to 27º C, in cooler and warmer regions respectively. Soil texture, soil productivity, native flora composition, cropping and farm systems are strongly affected by geomorphology and climatic conditions.

Alfalfa *(M. sativa)* is a drought and cold tolerant perennial legume, independent of soil nitrogen. According to Theophrastos it was introduced in Greece 2,500 years ago by the invading Medians. Grown in pure stands, alfalfa is mainly used for hay production. Silage and dehydration are not large expanded. Grazing after last cut or during the winter is traditionally applied in some cases. Alfalfa area was reduced from 250,000 to 114,000 ha during the last years. However alfalfa remains the most important fodder crop, producing 88 % of the total hay production. Most of the alfalfa area, 72%, is traditionally irrigated but, due to its extensive deep-rooted system, nonirrigated alfalfa could be expanded into the zone of cereals provided that the right varieties and the right management are applied (Vaitsis 1990a, 1990b, 1994a).

*M*edicago *arborea* is a drought resistant shrub, suitable for marginal rocky soil reclamation in Mediterranean dry-hot climatic conditions. According to Theophrastos and Dioscuridis it was known, in ancient Greece, as *Kytisus* or *Ebony*. Very widespread in the past, it decreased dramatically during last centuries, because of the heavy grazing and the fires. Today a small number of shrubs survive in certain protected habitats or are grown in gardens and parks of Southern Greece. *M. arborea* is susceptible to the frost and could be grown only in Southern Greece (Vaitsis 1993a).

Perennial grasses, cocks-foot *(Dactylis glomerata)*, ray-grass *(Lolium perenne)*, tall fescue *(Festuca arundinacea)* and perennial legumes, white clover *(Trifolium repens)* and red clover *(Trifolium pratense)* are the most important components of native flora in Greece but they are less known as crops (Vaitsis 1987, 1988, 1990c, 1993b). They are usually grown under irrigation as grass-legume mixtures for grazing, in about 3,000 ha. Irrigated grass-legume mixtures have a very high cost in Greece as the dry-hot summer period lasts three to five months. Growing these mixtures under rain fed conditions is the best way, provided that the right forage species and drought resistant varieties are used.

Wheat, burley, oats and ray are grown under rain fed conditions in about 1,063,000 ha. Annual grasses and legumes are grown for hay and grazing in about 142,000 ha (MA 1999). Every year ploughing, sowing, herbicides application and fertilising 1,205,000 ha of these crops has a high cost. Ploughing, and some other farming practices in hilly slopes cause soil erosion and soil degradation of arable land. About 480,000 ha of marginal fields have been abandoned during the last years. This abandoned area is increasing, as the norms of GATT and CAP do not favour cropping cereals in infertile marginal soils. A large part of the marginal fields into the zone of cereals should be covered by forages (Vaitsis 1994c, 1995, 1996, 1997b).

Natural grassland area is estimated in 5,200,000 ha but less than 60 % of these are actually used as pasture, since a large part of the named grasslands are rocky or dense shrub areas. Grasslands are highly diverse in topography, climate, soil texture, flora composi-tion, forage productivity and owner-ship. Most of the grasslands is public and grazing of the flocks, in native pasture, is free for all the farmers of the community.

Unbalanced distribution of animal stocks, lack of any management, overgrazing and wild fires are the main factors of pasture degradation. Stocking capacity has been dramatically reduced during the last centuries. However, these pastures still remain the largest natural resource for sheep and goat husbandry. As the sheep and goat flocks tend to be on the increase and as they are concentrating in certain areas, overgrazing is a usual phenomenon in plain and hill pastures, while abandoned area of mountain pastures increases. On the other hand as the hay production is reducing, the deficiency in animal feed is large and the concentrates consumption is increasing (Vaitsis 1987, 1993c, 1994b).

Research on fodder crops and pasture improvement in dry-hot conditions, is world wide limited. Some experiments carried out in Greece during the last decades, investigate these subjects. There were not any Greek forage varieties, except of those of alfalfa and the introduced varieties have been proved no good producers under rainfed conditions. That is why the research projects were focused mainly on breeding for drought resistance and persistence. (Vaitsis 1987, 1990b, 1993c,1994a,b). A brief review of the results of these projects is the subject of this paper.

B. MATERIALS AND METHODS

b-1. Collecting Germ-plasm.

First forage accessions were collected 77 years ago, when the Agricultural Research Station, now Fodder Crops and Pastures Institute (FCPI), was established in Larissa in 1923. Seed samples were introduced from other countries or were collected from Greek farmers stocks for experimental purposes. Collecting wild germ-plasm of perennial forages started in Central Greece in 1977 and was expanded almost all over Greece during 1982-86, thanks to a financial support of the FAO/IBGRI. Initial seed was harvested from a large number of plants, to include as much as possible of the existing variability in every site (Tyler 1987). In some other cases, when it was impossible to harvest seed, about thirty plants from each site were transplanted in isolated fields in Larissa. Some missions were carried out during 1991-95 in Southern Greece, especially for *M. arborea* collection in the framework of a EU project on fodder trees and shrubs.

b-2. Breeding.

Individual plants of cocksfoot, tall fescue, *Hedysarum coronarium*, perennial ray-grass, alfalfa, *Medicago arborea*, *Onobrychis viciafolia* and *Poterium sanquisorba* were evaluated, under rainfed conditions, for drought and cold resistance, disease tolerance, persistence, plant height, leaf/stem ratio, flowering or heading time and forage productivity. Initial seed was from Greek landraces or from wild indigenous populations. All these species are cross-pollinated and the proper breeding methods were used.

Large number of young seedlings of each species, developed in small pots, were transplanted in the field, spaced each other 25x50 or 50x50 cm apart. Selected plants were used in mass-selections or were further evaluated as clones, after vegetative propagation, in free pollination or in polycross progeny tests. Individual plants or seeded rows were used in these later tests. Most of the collected, introduced or created new populations were preliminary evaluated in small plots, in 1 or 2 sites. Promising varieties were evaluated for drought resistance, persistence and forage production in large plots of 10 to 15 m², in 2 to10

contrasted environment sites (Gray 1982, Hill & Baylor 1983, Hung *et al*. 1980). Randomised complete block design, in 3 to 4 replications, was used in all trials. All species were subject to a conservation management, with two to four harvesting cuts per year depending on the growth.

b-3. Farm practices and uses.

Promising varieties of perennial forage species were further evaluated under rain fed conditions, in pure stand or in mixtures, in a network of trials in contrasted environments. Randomised complete block designs with plots of 7 to 20 m² in 3 to 4 replications or larger plots of 100 to 250 m² in 2 replications have been used. Establishment methods, management, cutting regimes or grazing imitation, fertilisation and weed control of fodder crops were also investigated in both native or sown pastures.

C. RESULTS AND DISCUSSION

c-1. Collection.

A considerable germ-plasm collection has been created, including a total of 24 perennial forage species and 1636 accessions, 16% bred varieties, 45% breeders lines and clones, 3% land races and 36% wild populations (Table1).

Table 1.
Perennial Forages Collection in Greece. Number of accessions

	Collected species	Bred varieties	Land races	Wild populations	Breeders Lines,clones	Total
1	*Agropyrum spp*	-	2	21	-	23
2	*Aristella bromoides*	-	-	4	-	4
3	*Brachypodium spp*	-	-	8	-	8
4	*Dactylis glomerata*	25	-	167	70	262
5	*Festuca arundinacea*	30	-	34	210	274
6	*Festuca ovina*	1	-	2	2	5
7	*Festuca spp*	-	-	7	-	7
8	*Hedysarum coronarium*	1	-	-	2	3
9	*Hordeum bulbosum*	-	-	25	-	25
10	*Lolium perenne*	24	-	57	80	161
11	*Lotus spp*	1	2	19	-	22
12	*Medicago arborea*	2	-	36	55	93
13	*Medicago spp perennials*	2	-	5	-	7
14	*Medicago sativa*	125	30	7	267	429
15	*Melilotus spp*	-	-	9	-	9
16	*Onobrychis spp*	1	-	3	11	15
17	*Oryzopsis spp*	-	-	15	-	15
18	*Phalaris tuberosa*	-	-	8	3	11
19	*Phleum spp*	-	-	12	-	12
20	*Poterium sanquisorba*	1	-	14	-	15
21	*Trifolium hybridum*	5	2	1	-	8
22	*Trifolium pratense*	35	7	57	20	119
23	*Trifolium repens*	15	3	74	15	107
24	*Trifolium tomentosun*	-	-	2	-	2
Total number of accessions		266	48	587	735	1636

Bred varieties, clones and breeders lines are mainly maintained in Larissa, in room temperature, while land races and wild populations are maintained in the Greek Gene Bank in Thessaloniki in active collections (0° to 5° C). Safety duplication of accessions in Thessaloniki in base collections (-18° to -21°C) is the first priority. More accessions of indigenous alfalfa, tall fescue and perennial ray-grass need to be collected from the Southern Greece. Regeneration, characterisation and preliminary evaluation of collected populations is also needed (Vaitsis 1997a).

c-2. Breeding.

Great variability was found into and between populations of each species in all evaluated characters, flowering or heading time, drought and cold resistance, disease tolerance, persistence, plant height, crown diameter, forage productivity, leave stem ratio, winter and summer recovery. A considerable number of clones, breeder lines, mass selections and synthetics have been produced by selection. These Greek bred populations, when tested under rain fed conditions in contrasted environment sites, produce and last more than the introduced varieties.

The high variability of the rainfall was the main reason of the wide fluctuations in forage production of the varieties. The variations ranged from 60 % to 132 % of the check varieties between the regions and from 40 % to 157 % between the years of the experimentation (Vaitsis 1988, 1990b,c, 1999; Vaitsis *et al*. 1994; Vaitsis and Karamaligas 1996, 1998). Mass selection and synthetic varieties with larger genetic base are better adapted in diverse climatic and soil conditions. Eighteen of the most promising varieties of nine species have been registered in the national list of varieties (Table 2). Some more new synthetic or mass selection varieties are ready for registration.

Table 2
Varieties registered in the national list of varieties

Perennial forage species	Varieties	Seed availability	Drought resistance	Persistence under rain-fed
Medicago sativa	Cheronia	certified	low	medium
Medicago sativa	**Hyliki**	certified	high	long
Medicago sativa	**Hypati**	basic	high	long
Medicago sativa	**Dolichi**	basic	high	long
Medicago sativa	Pella	breeder's	medium	long
Medicago sativa	Florina	breeder's	medium	long
Medicago sativa	Lamia	breeder's	medium	long
Medicago sativa	Veria	breeder's	medium	long
Medicago arborea	**Naxos**	basic	high	long
Hedysarum coronarium	Aegion	breeder's	medium	medium
Poterium sanguisorba	**Amphiklia**	basic	high	medium
Dactylis glomerata	**Perevia**	breeder's	high	long
Festuca arundinacea	Metsovo	breeder's	low	medium
Lolium perenne	Olympion	breeder's	low	short
Trifolium pratense	Arni	breeder's	susceptible	short
Trifolium pratense	Nessonas	breeder's	susceptible	short
Trifolium repens	Konitsa	breeder's	susceptible	short
Trifolium repens	Tavropos	breeder's	susceptible	short

Hyliki is the main alfalfa variety suggested all over Greece for both irrigated or rain fed conditions. Mean annual hay yield of this variety, under rain fed conditions, is ranking from 7.25 to 18.48 tons/ha (Table3). Two hay cuts are obtained in the most stress conditions and three to five cuts in the favourable environment sites. *Dolichi* and *Hypati* are also drought resistant alfalfa varieties suggested all over Greece. (Vaitsis 1990b, 19994a, Vaitsis *et al.* 1994)

Table 3
Mean hay yield of alfalfa (variety Hyliki) under rain fed conditions

Location of experiments	hay yield Kg/ha per year	Rainfall in mm distribution		
		Year	October-May	June-September
Larissa	7,250	480	400	80
Varthates	9,060	560	488	80
Thessaloniki	9,890	480	400	80
Ptolemaida	10,710	430	340	90
Konitsa	12,210	1060	980	80
Arta	12,270	880	760	120
Palamas	14,010*	520	440	80
Orestiada	16,960*	560	440	120
Kalampaka	17,650	940	810	130
Aliartos	18,480*	560	510	50

** Subsoil water in high level.*

Medicago arborea variety *Naxos*, cocksfoot variety *Perrevia*, *Hedysarum coronarium* variety *Aegean Sea* and *Poterium sanquisorba minor* variety *Amphiklia*, can be grown under rain fed conditions even in the driest areas of the South-Eastern Greece (Vaitsis 1998, 1993a). Tall fescue variety *Metsovo*, perennial ray-grass variety *Olympion* and *Onobrychis viciafolia* have been also selected for drought resistance but perform better in cooler regions. Red clover and white clover varieties have not been selected for drought resistance (Vaitsis 1990c, 1993b, Vaitsis *et* al 1996, Vaitsis and Karamaligas 1998).

c-3. Farm practices and uses.

Native pasture productivity, perennial forages and their mixtures' persistence and productivity are strongly affected by soil and climate conditions, species, variety and management. Information on each investigated subject is summarised below.

Flora composition, forage production and forage quality of native pasture could be improved easily by a proper management and in some cases by a proper fertilisation and weed control. Re-sowing is suggested only in special cases when native flora is extremely deteriorated. Ownership and some other social or legal conditions are the main reasons for low exploitation of the native pasture area.

Alfalfa has large potentialities to be expanded all over Greece, even in the extreme dry environment of the Aegian Sea islands. Deep and rich rooted, soil nitrogen independent and drought resistant, this plant exploits well subsoil water and subsoil minerals. New Greek alfalfa varieties sown in early spring can survive 4 to 6 years even when the drought period is longer than 5 months and the total precipitation less than 400 mm. Total annual precipitation affects directly forage productivity but low annual precipitation and long dry summer period are not a limiting factors for alfalfa establishment and survival.

The most favourable time for alfalfa sowing is early spring, from February to mid-March in Southern Greece, from March to mid-April in Northern Greece. Suggested seed rate

is 10-20 Kg/ha and the suggested distance between sowing rows is 15-30 cm. When seed production is the main use, suggested seed rate is 5 to 10 Kg/ha and the distance between rows 40 to 60cm. Shallow acid, or flooded soils are limiting factor for alfalfa growing. Medium texture soils deeper than 1 m, rich in Ca with pH value from 6.5 to 7.5, are the best. There is not any need for nitrogen and potassium fertilisers (FCPI; Vaitsis 1990a, 1995) but only for 60-80 Kg of phosphorus per ha (Table 4). As the available water is getting less year by year, it is urgent to expand alfalfa under rain fed conditions into the zone of cereals. It is possible to reverse the irrigated – no irrigated alfalfa ratio from 72/28 to 25/75 (Vaitsis 1990a,b, 1994a,c, 1995, 1996; Vaitsis *et al*. 1994).

Table 4
Suggested fertilisers for perennial forages wheat and barley, Kg/ha

Forage species	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)
Alfalfa	0	70-80	0
Medicago arborea	0	0	0
Hedysarum coronarium	0	50-60	0
Grass-Legume mixtures	40-50	40-50	0
Poterium sanguisorba	60-70	50-60	0
Cocksfoot	100-120	50-60	0
Tall fescue	100-120	50-60	0
Prennial ray-grass	100-120	50-60	0
Wheat and Barley	100-120	40-50	0

Medicago arborea is a high drought resistant shrub suitable for dry rocky, calcareous soils reclamation. It usually drops its leaves during the dry-hot summer period but it has the ability to recover early in the autumn and remains green during the period, from mid-October to the middle of the summer. Thanks to its nutritive green leaves and shoots, lumi-nous yellow flowers, long flowering time and attractive looking form, it is used for grazing, bee feeding and for ornamental decoration in dry rocky areas. The best time to harvest seed is early summer, to sow seed in pots is early spring and to root cuttings middle autumn. Favour-able time for young seedlings' or rooted cuttings' transplantation in the field is autumn, after the first sufficient rainfall. Cold is a limiting factor for *M. arborea* development in Central and Northern Greece but not in Southern country and Aegean Sea islands. Soil acidity is a limiting factor for growing *M. arborea* but not the soil fertility. These shrubs should be grown in skeleton, rocky calcareous soils that are in abundance in Greece. It could be used for rocky soil reclamation, sheep and goat grazing, bee feeding and for gardening (Vaitsis 1993a, 1996, 1997b).

Hedysarum coronarium is a legume a little more cold resistant than *M. arborea*. Sown in early autumn or early spring, it performs as perennial in warmer regions, but as annual or biennial in cooler regions. It could be used for grazing, bee feeding and for ornamental decoration. *Onobrychis viciafolia* could be used in cooler and frost suffering regions of the Northern Greece instead of *Hedysarum coronarium*.

Cocksfoot is a drought resistant perennial grass adapted in contrasted environment from the sea level to 2,000 m in altitude, from the Southern to the Northern regions of Greece. Greek variety *Perevia* could be grown as pure stand or in mixtures, all over Greece, under rain-fed conditions, for grazing, silage, hay production, road side decoration, soil protection and in some cases as turf. Favourable sowing time is early in the autumn after the first sufficient rainfall. In some cases, in cooler humid regions, cocksfoot could be sown early in the spring. Suggested seed rate is 10 to 20 Kg/ha and suggested distance between sowing

rows is 15 to 30 cm. Best stand management is one cut for hay in heading time in spring and grazing at 3 to 4 weeks intervals provided that plant height is 15-25 cm. Under this management, *Perevia* survived more than 5 years while introduced varieties disappeared during the second or third year (Vaitsis 1988,1993b).

Tall fescue v. *Metsovo* and perennial ray-grass v. *Olympion* could be grown under rain fed conditions, in cooler regions, for the same purposes as cocksfoot. Most favourable sowing time is in the early autumn after sufficient rainfall. Management and other farm practices are the same as for cocksfoot, except seed rate that is 20-30 Kg/ha (Vaitsis 1990c, 1993b, Vaitsis *et al*. 1996; Vaistis and Karamaligas 1998).

Grass-legume mixtures under rain fed conditions are suggested to minimise nitrogen use and bloating danger for the grazing animals. When more than two species were used, there was a great competition between them and usually no more than two species survived. Cocksfoot and alfalfa mixture is suggested all over Greece. Tall fescue or perennial ray-grass in combination with alfalfa or white clover are suggested for the cooler humid regions. *Trif. Subterraneum and Poterium sanquisorba* should be used in acid soils. Planting *M. arborea* shrubs in combination with cocksfoot is suggested for abandoned rocky soils, reclamation and stabilisation.

Drought resistant perennial legumes and their mixtures with perennial grasses have great potentialities to be expanded, under rain-fed conditions, into the zone of cereals (Tables 5 and 6).

Table 5
Yield of some crops under rain fed conditions (forage dry matter, Kg/ha)

Crops	Farming practice	Experimental data	
	Mean	Mean	Variation
Alfalfa, hay	6,500	14,500	7,500 ⇒ 18,500
Medicago arborea	No information	4,000	2,000 ⇒ 7,000
Perenneal forages, pure or mixtures	No information	6,000	2,000 ⇒ 13,000
Annual forages	3,700	5,000	2,500 ⇒ 8,000
Wheat, Barley, oats, ray *	2,500	3.500	1,500 ⇒ 8,000

** Grain dry matter*

Table 6
Distribution and perspectives of some arable crops (area in ha)

Crops	First estimation for 1999		Expectation for 2010	
	area in ha	irrigated %	Area in ha	irrigated %
Alfalfa, hay	113,200	72	300,000	25
Medicago arborea	?	0	100	0
Perennial grass-legume mixt, grazing	3,000	90	60,000	10
Annual forages, hay	62,000	7	60,000	10
Annual forages, grazing	80,000	4	50,000	10
Wheat-barley-oats-ray, grain	1,063,000	0	900,000	0
Total	1,321,200	-	1,370,000	-

More than 200,000 ha of cereals could be replaced by these new crops, especially by pure alfalfa. Alfalfa and other legumes have not any need for chemical nitrogen under Greek soil and climate conditions. Usually, in normal soils, there is not any need of K_2O for legumes

and grasses as well (Table 4). There is also no need for herbicide and insecticide consumption except in some special cases.

D. CONCLUSIONS

- Land degradation is a universal problem in continuing process. The problem is increasing more and more in Greece during last years.
- Drought resistant perennial forages could be used, for supporting extensive livestock production systems in arid or semi-arid areas.
- Alfalfa, cocksfoot, *Poterium sanqisorba, Hedysarum coronarium* and their mixtures, grown under rain fed conditions could replace wheat in large area into the zone of cereals.
- Tall fescue, perennial ray-grass, white and red clover, should be used for the same purposes only in the cooler regions.
- *Medicago arborea* is the most suitable fodder shrub for marginal rocky soil reclamation in Southern Greece. Cocksfoot should be used as an accompany crop in these plantations.
- Development of these new crops in dry lands is economically positive, fitting well at new GATT and CAP norms.
- Social, economic and environmental benefits are obvious:
    - Protecting soil against splashing rain, water runoff and erosion by dense deep penetrating root system and by all year ground covering.
    - Stabilising waterways and slope fields, conserving soil and water resources.
    - Improving soil fertility and structure,
    - Saving water, energy and chemical herbicides, insecticides and fertilisers.
    - Protecting against soil and water pollution.
    - Favouring native flora and native fauna conservation, abandoned skeleton soil reclamation.
    - Improving environment and site aesthetic situation.
    - Improving crops rotation, especial that of the cereals, supporting integrated agriculture and extensive livestock production systems.
    - Reducing concentrates consumption in animal feeding, smoothing animal production and improving quality of the products.
    - Increasing farmers income in disadvantaged regions, and stabilising rural population.
- New Greek varieties named in Table 1 are suggested but more co-ordinated research is needed on breeding for drought resistance, persistence and plant productivity. Special research is also needed on establishment methods and management.
- Proposing concerted actions and pilot projects on expanding drought resistant perennial forages under rain fed conditions is the first priority.
- Proposing changes in EU/CAP subsidies in order to support growing perennial forages under rain fed conditions as a desirable environmental activity in the Mediterranean EU countries is another priority.

E. REFERENCES

CERIALS INSTITUTE (CI), Thessaloniki. Personal communication.
FODDER CROPS AND PASTURES INSTITUTE (FCPI), Larissa. Unpublished data.
GRAY E.,1982. Genotype x environments interactions and stability analysis for forage yield of orchard-grass clones. Crop. Science, 22:19-23.
HILL R. and BAYLOR J., 1983. Genotype X Environment Interaction Analysis for Yield in Alfalfa. Crop. Science, 23:811-814.
HUNG N. et al., 1980. Genotype x environment interactions for herbage yield of tall fescue synthetics. Crop. Science, 20: 221-224.
MINISTRY OF AGRICULTURE (MA), Athens. Personal communication.

TYLER B.,1987. Collection, Characterisation and utilisation of Genetic Resources of Forage Grass and Legumes IBPGR Training Course in WPBS/UK, Bulletin.
VAITSIS Th., 1987**.** Grasslands and Fodder Crops in Greece. E.E.C meeting proceedings. Agriculture, EUR 11170 EN, p. 185-191. Eng.
VAITSIS Th**.,** 1988. Breeding *Dactylis glomerata* from Wild Indigenous Germ-plasm. 2nd Congress of Greek Breeders Society in Thessaloniki. Proceedings, p. 53-62. Gr.
VAITSIS Th., 1990a.Alfalfa. A dynamic crop. Present and future. Agrotica, 41:32-35. Gr.
VAITSIS Th., 1990b. Alfalfa Varieties Evaluation under Rain-fed Conditions. Agricultural Research Congress in Thessaloniki. Proceedings, p. 183-199. Gr.
VAITSIS Th., 1990c**.** Breeding *Festuca arundinacea* from Wild Indigenous Germ-plasm. Agricultural Research, 14:55-67. Gr.
VAITSIS Th., 1993a. Breeding *Medicago arborea* for Mediterranean conditions. Agriculture EUR 14459 EN, p. 171-175. Eng.
VAITSIS Th., 1993b. Collecting and Breeding Wild Indigenous Germ-plasm of Perennial Grasses FAO, meeting in Chania Greece. REUR Techn. Series 28, p. 50-55. Eng.
VAITSIS Th., 1993c. Native grasslands. Valuable National Resource. Agrotica, 45:22-28. Gr.
VAITSIS Th., 1994a**.** Alfalfa Varieties Evaluation and Alfalfa Stand Establishment under Rain-fed Conditions in Greece. REUR Techn. Series 36, p.227-229. Eng.
VAITSIS Th., 1994b. Animal Feeding. Problems - Perspectives. Agrotica, 45:14-21. Gr.
VAITSIS Th. 1994c Sown Meadows-Fodder Crops. GEOTEE Panhellenik Congress in Ioannina-Greece. Proceedings p.145-159. Gr.
VAITSIS Th., 1995. Possibilities and Perspectives for Fodder Crops and Sowed Pastures development. Hellenic Meadows Society meeting in Thessaloniki. Proceedings. p. 44-66. Gr.
VAITSIS Th., 1996. Drought Resistant Perennial Forages for Combating Desertificatioon. EU scientific international conference in Heraklio-Greece. Proceedings. Eng.
VAITSIS Th., 1997a. Status of national forages collections in Greece. IRGRI ECP/GR meeting in Beitostolen-Norway. Proceedings. p. 73-76. Eng.
VAITSIS Th., 1997b. Marginal Dry Soil Reclamation by Sowing Perennial Forages. Aegean Sea University, international meeting in Lesvos-Greece. Proceedings, p. 45-53. Gr.
VAITSIS Th., 1999. Collecting and Breeding *Medicago* Perennial Species in Greece. EUCARPIA scientific meeting in Perugia-Italy. Proceedings. Eng.
VAITSIS Th. et al. 1994. Research on nonirrigated Alfalfa in Greece and Integrated Agriculture. Congress of Greek Breeders Society in Volos-Greece. Proceedings, p. 260-267. Gr.
VAITSIS Th. and KARAMALIGAS Ch., 1996. Collection, Selection and Evaluation of Tall Fescue Germ-plasm. Congress of Greek Breeder's Society in Florina-Greece. Proceedings. P.102-11 Gr.
VAITSIS, Th. and KARAMALIGAS Ch., 1998. Collecting and Breeding Wild Germ-plasm of Perennial Ray-grass. Congress of Greek Breeder's Society in Heraklio-Greece. Proceedings. Gr.