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PORTUGAL UNIVERSITY INSTITUTES DEVELOPMENT PROJECT

(Contract AID/NE-C-1701)

REPORT ON
SHORT-TERM STAFF ASSIGNMENT

Submitted by
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Waite Agricultural Research Institute
The University of Adelaide
Glen Osmond, South Australia

May 8 - June 6, 1982

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PREFACE

Portugal, like many countries of the world, has a serious deficit in human food and livestock feed production which has been aggravated by loss of her colonies. Though massive imports of wheat and feed grains have given temporary relief this is no long-term solution. To rectify these shortages more attention and finance must now be devoted to the agricultural sector. The emphasis must be on increasing self-sufficiency in human food and livestock feed production. Hence it is most appropriate that Portugal not only mobilises its own resources in research and development in the agricultural sector but also draws on appropriate technology and experience from analogous ecological zones of the world.

The US AID program of assistance to the University of Evora is a fine example of foreign aid and US AID, Purdue University and the University of Evora are to be commended for recognizing that southern Australia's agricultural technology, and experience is highly relevant to the Alentejo.

With the probability of Portugal joining the EEC it is obvious that the future of the Alentejo lies in rainfed animal production, especially sheep-meat production. Thus there is an urgent need to examine problems of pasture and livestock production and the scope for improved crop-livestock integration. In this respect the Alentejo is fortunate in having great scope for pasture improvement and increased livestock production. Legume-based pastures and forage crops will not only improve livestock production but also raise soil fertility and consequent yields of cereal crops in the rotation.

The brief interim report that follows represents a broad appraisal of some important agricultural research and development needs of the Alentejo with particular emphasis on the pasture-livestock sector. I have avoided reporting on well-known and relatively static physiographic, climatic and edaphic features of the Alentejo and have concentrated on those aspects related to the dynamic pasture-crop-livestock farming systems and the potential for change.

My first visit to the Iberian Peninsula was in May 1973 to review the FAO pasture-livestock work based at Finca "La Orden", Badajoz, Spain. I revisited southern and south west Spain (Extremadura) and the Elvas Research Station and surrounding districts in May 1974. My visit to Portugal (and Spain) from May 9 to June 4, 1982, reinforced earlier impressions of these regions and my travels in the Alentejo have given me a clear picture of the existing and potential land use and some of the related agronomic, economic and social problems of this region.

Since my first visit to the Iberian Peninsula, I have been impressed by the marked ecological analogies between the Extremadura of Spain, the Alentejo of Portugal and South Australia and I realised that southern Australia had a great deal to offer in the science and technology of land clearing, pasture improvement and general techniques related to cereal and livestock production and integration of these enterprises.

The background and terms of reference for this consultancy are included as Appendix A. I was given permission to be absent from my University during the four-week first term vacation and my itinerary is detailed in Appendix B.

The various matters referred to in the terms of reference are either covered in this brief report or were covered in my seven formal seminars and associated discussions held at Mitra, Elvas, Fonte Boa and Lisbon. To avoid confusion in terminology the definitions of pasture, rangeland, forage crop and fodder are shown on page v.

I trust that this brief report will focus attention on some serious challenges to agricultural research and extension in the Alentejo and it is hoped that the comments will serve as a guide for more-detailed discussion inspections and data collection in the Alentejo which I hope to undertake in the spring of 1983. These will form the basis of a more detailed report along the lines of Carter (1966, 1974, 1978).

My thanks are due to the many people in Portugal who helped me to fulfil my mission and to make my stay both useful and enjoyable. I am most grateful to those persons listed in the Itinerary, and any who may have been inadvertently omitted, who gave of their time and knowledge.

I am especially grateful to Professor Ario Lobo Azevedo, Rector of the University of Evora, for his help and encouragement; Dr. John Sanders Purdue University representative at the University of Evora, for his continual guidance, friendship, translation and for making all detailed arrangements in Portugal; Professor Carlos Portas, Head of the Agronomy Department and Director of the Mitra Experiment Station, for making various arrangements; Pedro Silveira, Ermelinda Pinheiro, Rosario Oliviera (Agronomy Department), Afonso de Almeida and Manuel Cancela d'Abreu (Animal Science Department) and Professor Mariano Feio all of the University of Evora; Professor Dr. Pereira da Silva, Director of INIA; Jose Barbas Guerra, Director, and David Gomes Crespo, Chief of the Department of Forages and Pastures, of the INIA Plant Improvement Station, Elvas; Dr. Joao Ramalho Ribeiro, Head of the Nutrition Department, INIA National Livestock Station Fonte Boa; Jose Almeida Alves, INIA Coordinator of the PROCALFER program; Joaquim Dordio and his dedicated PCAA staff for showing and discussing their World Bank development work in the Alentejo; Teodosio Salgueiro, MACP Department of Rural Extension; and Andre Dordio, Chief of the Division of Animal Feeding, MACP.

Finally, it is a pleasure to record my thanks to the US AID Mission in Lisbon and Purdue University for providing financial assistance to enable me to undertake this Consultancy in Portugal.

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23/12/82

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DEFINITIONS OF PASTURE, RANGELAND, FORAGE CROP AND FODDER

While there is no universal agreement on terminology, the following definitions apply to the terms, listed below, that are used throughout the report.

(i) Pasture: A dynamic community of plants subjected to the various influences of the grazing animal (treading, defoliation, recycling of nutrients, dispersal of seeds). The pasture may be a mono-specific sward or a complex community of many genera and species. The general term embraces the full range of environments, e.g. from steppe rangelands to mountain meadows.

(ii) Native Pasture: Pasture dominated by indigenous perennial species (but often with associated annual species), including both climax and disclimax pastures.

(iii) Natural Pasture: Volunteer (or spontaneous) pasture resulting from the activities of man and his grazing animals but without artificial sowing. Natural pasture is commonly characterized by dominance of annual species, frequently naturalized species introduced from elsewhere. The volunteer species may be the same species as are frequently sown, e.g. *Medicago truncatula* and *Trifolium subterraneum* which have spread naturally in many areas of southern Australia.

(iv) Sown Pasture: Annual and/or perennial species sown (usually with fertilizer) to increase the livestock carrying capacity of the area. The process is also referred to as pasture improvement when one or more species is introduced either on cultivated soil or into native or natural pasture.

(v) Permanent Pasture: Pasture developed by sowing perennial species with or without associate annuals and usually in higher-rainfall areas. The perennial species confer stability of botanical composition but do not necessarily increase pasture productivity.

(vi) Rangeland: Arid-zone pasture (including steppe) dominated by perennial species and unsuited to cropping because of aridity or steep and shallow soils: generally not capable of improvement without exclusion of grazing animals, and furrowing, pitting, etc., to collect seed and water. Although ecologically possible to improve by oversowing appropriate species this is generally economically impracticable. Conservative stocking is obligatory.

(vii) Forage Crop: Green crop sown to supplement normal pasture and frequently cut and carted to feed livestock. These forage crops may be sown annual species, e.g. vetch, with or without associate cereal, for winter feed; turnips, sudan grass, etc., for summer feed; or perennial species like alfalfa or sainfoin.

(viii) Fodder: Any dried and stored or conserved feedstuff e.g., cereal hay, straw, cereal grain, pasture hay, forage hay, swedes, fodder beet, etc.

I. COMPARISONS BETWEEN THE ALENTEJO AND SOUTHERN AUSTRALIA

1. Climate, Soils and Vegetation

The Alentejo region of Portugal lying between Lat. 37° and 39°N is ecologically analogous to parts of southern Australia with a typically Mediterranean-type climate. At equivalent latitudes, altitudes and distances from the sea the temperature and rainfall patterns are remarkably similar. For example, data from five stations in typical subterranean clover pasture areas of South Australia and at Evora, Portugal, are as follows:

Station	Altitude (m)	Precip'n (mm)	Max. Temp. (°C)	Min. Temp. (°C)
Adelaide	43	533	28.5 Jan.	7.9 July
Naracoorte	58	586	28.4 Jan.	4.7 July
Waite Institute	122	627	28.5 Jan.	8.2 July
Clare	398	632	30.1 Jan.	3.4 July
Mt. Barker	330	781	27.0 Jan.	4.3 July
Evora	309	656	30.1 July	5.7 Jan.

Sources: Climatic Averages South Australia. Bureau of Meteorology, 1975. Meteorological Office, Part III Europe and the Azores. HMSO, London, 1972.

Furthermore, statistical analyses done on monthly rainfall data for the period 1931-60 for Evora, Beja, Elvas and Reguengos show that the rainfall patterns and coefficient of variation percentages for the months October through to May are very similar to the corresponding April to November period at the Waite Institute, Naracoorte, Clare and Mt. Barker in South Australia. These comparative climatic studies are continuing and it is hoped that these will be reported in more detail elsewhere in a joint project with Professor Mariano Feio. There is no evidence to support the view that climatic differences between the Alentejo and typical subterranean clover areas of southern Australia explain failures of sown pastures. These failures are ascribed to inappropriate choice of pasture species, cultivars and mixtures for sowing in the Alentejo, coupled with insufficient attention to detail in the establishment and management of these pastures. (These aspects will be dealt with later.) The Commonwealth of Australia (1982) booklet on the climate of Australia provides further supporting data.

It has also been suggested that failure of sown pasture in the Alentejo is due to extremely infertile soils of low pH. Again, most of the Alentejo soils are better endowed with nutrients and no more acid than huge tracts of virgin scrub and forest land cleared and sown to subterranean clover pastures in the 1950's and 1960's in southern Australia. (Stephens and Donald 1958, Stephens 1962, Carter and Heard 1962, Carter and Wigg 1963, Stace *et al.* 1968, Carter 1970, Northcote *et al.* 1975).

The Atlas of Australian Resources, Vol. 1 *Soils and Land Use* (1980) shows clearly the dominance of soils with chemical or physical limitations in southern Australia. By world standards, Australian soils are most infertile - especially the acidic deep siliceous sands, lateritic podzols Carter (1970), and solodic soils commonly used for sown pastures based on subterranean clover. Certainly, there are large areas of neutral to alkaline soils in the cereal belt in southern Australia where the annual species of *Medicago* replace the various cultivars of subterranean clover because soil pH is too high and rainfall too low for subterranean clover (Carter 1975, Carter, Wolfe and Francis 1982).

Of course the most convincing evidence is the fact that the naturalized flora of southern Australian subterranean clover and annual medic areas is almost exclusively composed of species from the Mediterranean Basin including the southern Iberian Peninsula. It is noteworthy that most of the subterranean clover and medic pasture in Australia is based on naturalized regional ecotypes which were accidental introductions following white settlement. This naturalized flora of legumes, grasses and weeds in southern Australia sets seed even in the most severe droughts just as was observed with the native species of legumes, grasses and weeds in the Alentejo in the severe spring drought of 1982.

The references listed provide ample evidence of basic similarities of the physical resource base for agriculture in the Alentejo vis-a-vis southern Australia: however, existing land use in the Alentejo and southern Australia differs in one important detail: in southern Australia much more emphasis is placed on the role of the self-regenerating annual legumes - subterranean clover and *Medicago* species - in the cereal crop-pasture rotation than in the Alentejo.

2. Land Use and Farming Practices

In Australia some 40 million hectares of crop and sown pasture land rely on annual legumes for soil nitrogen fixation and to guarantee the quantity and quality of livestock feed. These legumes are worth at least $2500 million per annum to the crop and livestock industries of Australia (Carter 1981).

In the Alentejo current land use is 1.59 million ha in agriculture, 0.95 million ha in agro-forestry and forestry, and 0.10 in urban use reserves, etc., involving a total area of 2.64 million ha. In terms of land capability classes (Salgueiro *et al.* 1964) there are some 1.5 million ha in classes C, D and E potentially available for improved pastures in the Alentejo. Yet, currently D.G. Crespo (priv. comm.) suggests that there is probably only 20,000 ha of reasonable subterranean clover-based pasture in the Alentejo. Thus there is ample scope for pasture improvement using subterranean clover, serradella, medics and other species according to soils and rainfall. However, the payment of 1000$00 per hectare subsidy to encourage wheat growing is a major disincentive to pasture improvement in the Alentejo and this is reflected in exploitation of soils for cropping, and serious soil erosion.

II. AGRICULTURAL PROBLEMS OF THE ALENTEJO

The agricultural problems of the Alentejo are very similar to many areas in the Mediterranean Basin (Carter 1974, 1975, 1978). Ten major problems are listed here but the list could be extended considerably.

1. Soil Erosion

This is particularly severe on some of the class C, D and E soils and is aggravated by excessive, deep cultivation, long periods of exposed soil in bare fallow and, in some cases, through excessive denudation by over-grazing.

2. Poor Soil Structure

This is associated with low levels of soil organic matter and excessive cultivation, often when the soil is too wet or too dry. Deep ploughing is a major cause of poor soil structure and a major problem of the Alentejo. The tradition of deep ploughing is shrouded in mystery: many theories are advanced but negligible data is available to support deep ploughing. Whatever the excuses for justifying deep ploughing in the Alentejo, there can be little doubt that regular ploughing to 30-40 cm depth at a cost of $100/ha is both unnecessary and a waste of money.

The most common reason given in the Alentejo is that deep ploughing is necessary to bury weeds but I saw no example of reasonable weed burial, sufficient to bury weed seeds too deep to emerge. The facts are that properly-timed shallow tillage can destroy weeds before seed set in the case of long fallow and allow satisfactory infiltration at a fraction of the cost and without causing a deterioration in soil structure.

3. Unsuitable Tillage and Sowing Equipment

Tractor-mounted ploughs and other tillage implements cause rough seed-beds and contribute to excessive wear and tear of harvesting machinery and other implements on broad scale farms.

In the Alentejo, timing of tillage for seedbed preparation and sowing operations is most important because moisture is often limiting. The size, design and ruggedness of implements is critical to ensure that large areas are covered rapidly, effectively and cheaply. Five basic features are needed for tillage and sowing equipment to be versatile, as follows:

(1) Stump-jump (SJ) principle - to allow passage over solid obstacles without damage.

(2) Clearance - to handle trash and allow passage over solid obstacles.

(3) Strength - for long life and minimal maintenance.

(4) Wheeled - for proper depth control and to provide a levelling action.

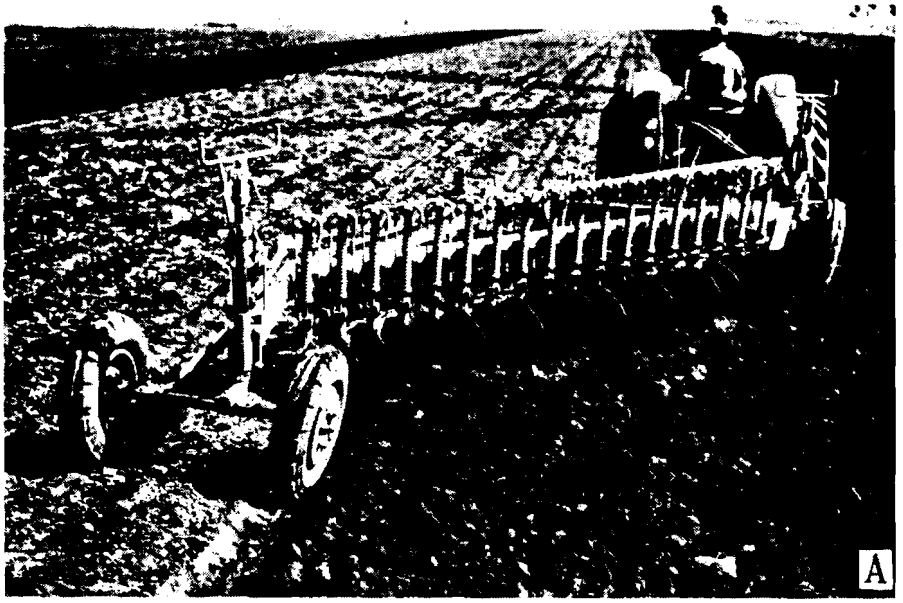
(5) Width - for rapidity of operation and to provide a levelling action.

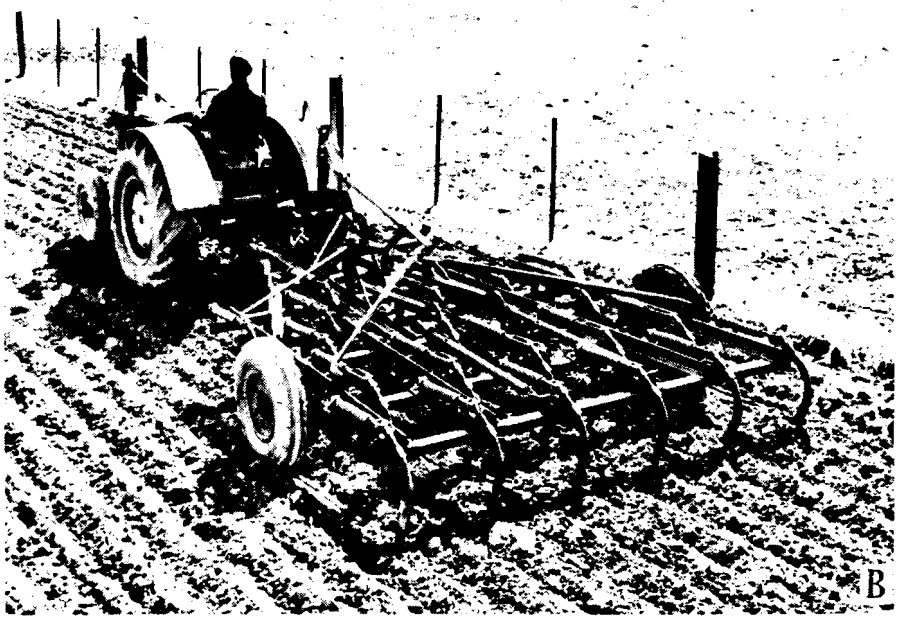
The SJ principle is standard on Australian ploughs, scarifiers, seed and fertilizer drills (or combines) where under-frame clearance is generally 45-50 cm and disc or tyne clearance 30-45 cm (Plate 1).

PLATE 1

Typical South Australian tillage and sowing implements used on cereal-livestock farms. The stump-jump mechanism which allows discs or tynes to pass over solid obstacles (e.g. rocks) without damage, functions through compression of a strong spiral spring in each of these three implements though springtyne cultivators (scarifiers) are common, especially in the wider, lighter-draught implements. Note the wheels for depth control, the width of implements and the shallow tillage. The spring-release combine (combination drill and cultivator) shown with typical light trailing harrows has three optional, easily-changed under-carriages, *viz.*, spring-tyne, trash-discer and disc-drill undercarriages.

(Photographs: Original prints from John Shearer and Sons Ltd., Kilkenny, South Australia).





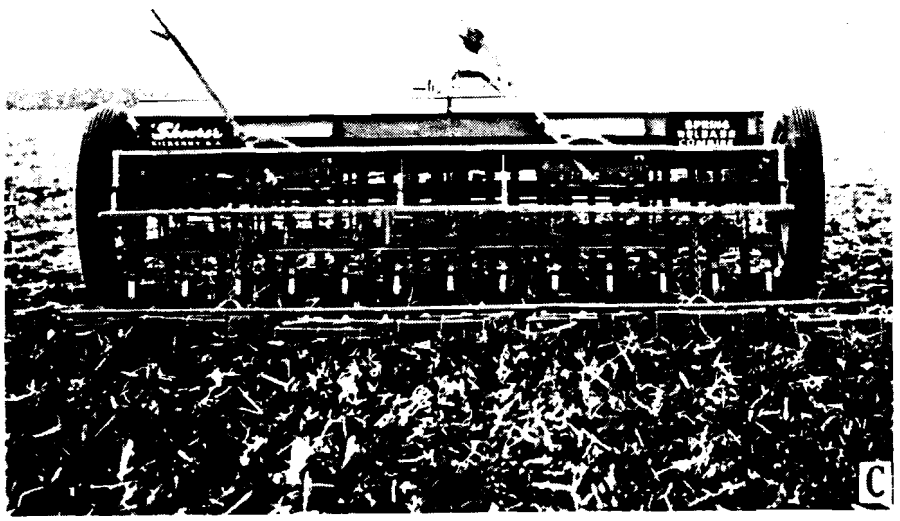
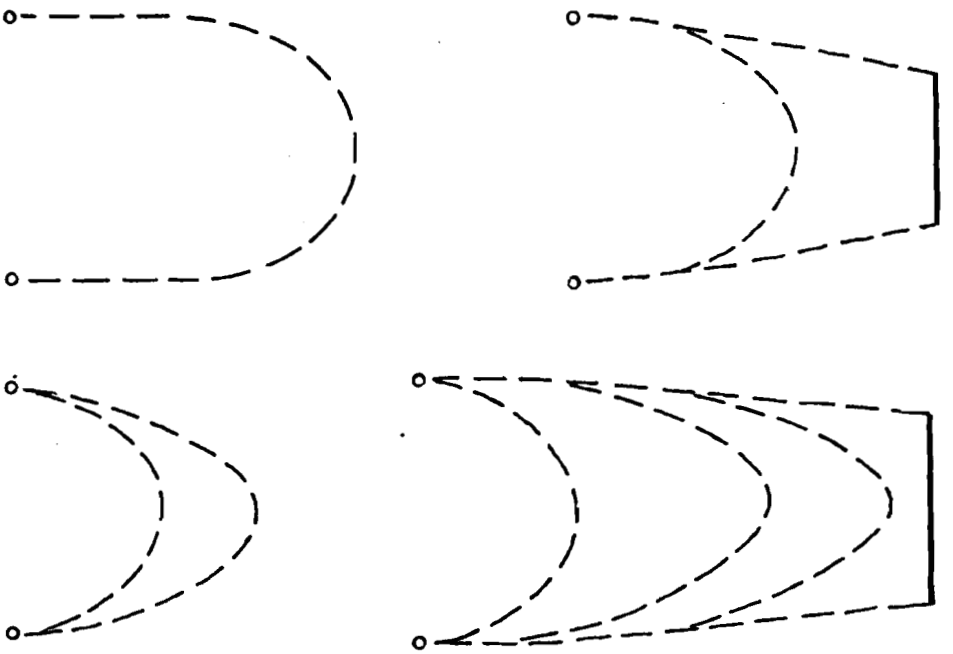


FIGURE 1

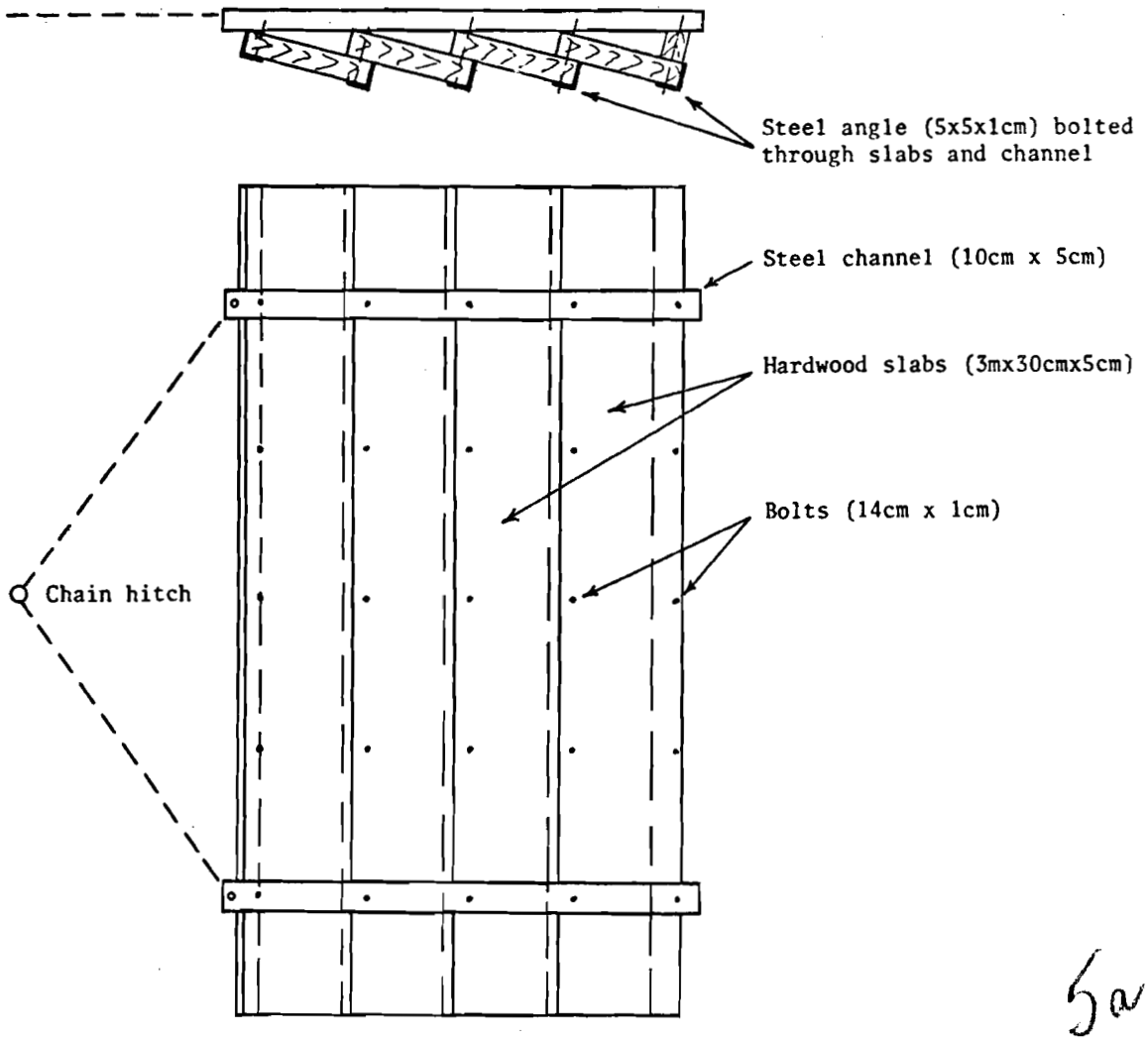
Upper: Typical chain rigs for clearing trees or shrubs or for the preliminary levelling and consolidation of newly-ploughed or ripped land. Simple chain rigs (without spreader) will effectively row tree stumps, rocks, etc., providing the tractors are not travelling too far apart.

Lower: A typical slab leveller designed for use with a medium-powered tractor. The height of hitching the tractor will determine the volume of soil 'carried' in front of the leveller and available for filling depressions in the soil surface.

TYPICAL CHAIN RIGS



TYPICAL SLAB LEVELLER



5a

In southern Australia, a ploughing and subsequent tillage depth not exceeding 8-10 cm is adequate and should suffice in most areas of the Alentejo. In fact, to guarantee survival of the self-regenerating subterranean clovers and annual medics in the crop-pasture rotation, shallow tillage is essential.

Tyned implements, especially if wheeled, have special advantages in levelling and preparing an ideal seed-bed. Various types of cheap and effective levelling devices are shown in Figure 1. The range of options in tillage and sowing equipment is detailed in Carter (1974, 1975).

4. Serious Weed Problems

Weeds decrease crop yields and increase costs of production through extensive herbicide spraying. In the stubble year insufficient sheep and lack of fencing preclude timely, high-density stocking hence weedy pastures are a sign of poor grazing management.

Many of the weed problems in cereal crops are directly related to tillage practice. Cultivations are often poorly timed through lack of suitable wide tillage implements and the control of tillage depth is inadequate. It is essential to progressively reduce the depth of successive cultivations to avoid bringing fresh weed seed up to the soil surface and encouraging germination and emergence.

More suitable tillage implements, more timely cultivations and more dense leguminous pastures are needed to help control weeds.

5. Poor Volunteer Pastures

The quality and productivity of many volunteer pastures in the Alentejo has suffered from early ploughing (long fallow) which prevents seed set and deep ploughing which buries seeds of legumes and grasses too deep to allow emergence and establishment.

6. Poor Sown Pastures

A common fault in the Alentejo as in south west Spain is to place undue reliance on later-maturing cultivars of subterranean clover. Daliak is the earliest-maturing cultivar used and it is sown extensively with Seaton Park, Woogenellup and Clare. However, this mixture is not early enough to cope with a dry spring as experienced in 1982. It is essential to use earlier-maturing cultivars like Nungarin and Northam in the mixtures for the Alentejo. (These cultivars are about 3 weeks earlier than Daliak.)

Later maturing cultivars of subterranean clover e.g. Clare, Woogenellup and Mt. Barker under poor spring conditions set little or no seed, the seed is small and lacks hard seededness and a lower percentage of pod is buried. Hence the seed from these later cultivars is ecologically far less fit. It is essential to use a mixture of four or five cultivars to cater for different moisture regimes (slope, aspect, depth of soil infiltration, water-holding capacity, etc.) Rainfall alone is a poor guide to the likely success of cultivars of subterranean clover.

While subterranean clover is likely to be the most important pasture legume in the Alentejo, other species e.g. serradella (on deep acid sands), medics (on neutral to alkaline soils), strawberry clover, white clover and Persian clover will all have a place. So too will alfalfa on some irrigated sites. However, neither irrigated pastures nor N-fertilized grass swards are the solution to livestock feeding in the Alentejo: both are too expensive except for very special situations. Rainfed pastures based on self-regenerating annual legumes are the main objective in the Alentejo.

In the case of annual pastures, the major determinant of winter production is density: yield is linearly related to density early in the season. Hence persistence and seed production is much more important on a year-round basis than is potential spring yield of a cultivar or mixture.

In the Mediterranean environment of the Alentejo it is inevitable that in the summer-autumn period the dry pasture residues may be deficient in energy or protein for growing animals. However, if there is a good percentage of legume the dry feed is a satisfactory maintenance diet for adult animals especially if a considerable amount of legume seed is being consumed. Relative palatability of species in the green pasture is of little consequence (providing not toxic) as all species are eaten by late summer or autumn in a Mediterranean environment like the Alentejo.

7. Poor Grazing Management

Leguminous pastures based on subterranean clover or annual medics should be grazed at a height of 5-8 cm up until flowering when grazing pressure should be reduced. After seed maturity care must be taken to avoid excessive consumption of legume seed by sheep (Carter 1981; Carter, Wolfe and Francis 1982).

Fencing is required for proper grazing management of sown pastures: it can be light-weight fencing for sheep at a much cheaper cost than traditional fencing in the Alentejo. It should be obvious that shepherded livestock, moving greater distances than if confined, cause unnecessary damage by treading and waste a lot of energy in walking. Fencing is also required for disease control e.g. footrot.

8. Confusion over Lime and Fertilizers

It is highly probable that many of the alleged responses to lime in the Alentejo are, in fact, responses to molybdenum through mobilization of the molybdenum at the higher pH caused by the lime. Much more definitive research is needed to clarify the relative roles of lime, molybdenum and other fertilizers needed for legume nodulation, pasture establishment, and productivity.

9. Poor Hay Quality

Almost all hay seen in the Alentejo was of very poor quality. There are apparently several reasons for this. There appears to be no separate forecast of weather for the Alentejo farming areas so farmers, in listening to Lisbon forecasts of rain, delay hay cutting. This situation needs rectifying. Furthermore, there is no price incentive for good hay so farmers who sell hay tend to go for maximum dry matter yield rather than quality. Certainly the Alentejo has no special problems relating to the potential for making good hay. What is needed is some price incentive coupled with a research and extension effort to show the advantages of good-quality hay. Timing of hay making operations is vital: good hay cannot be made if farmers or farm workers want to work only factory or office hours.

Most soil preparation on hay fields was extremely rough - certainly too rough for cutting low as required for pasture hay. Hence potential pasture hay yields are underestimated.

Despite these problems of hay making, hay should take precedence over silage in the Alentejo as it does in all Mediterranean areas of the world.

10. Insufficient Pasture/Animal Research and Extension Workers

Having regard to the existing and potential importance of pasture/forage crop production in the Alentejo, the current research effort in terms of research workers and finance for maintenance and travel is quite inadequate.

A major research and extension effort is needed, coupled with appropriate incentives. The crop-pasture-livestock integrated farming system needs far more attention especially on class C and D soils.

Perhaps the time is right to re-deploy some of the discipline-orientated research workers to work in teams to help solve real field problems. While excellent research is being undertaken at Oeiras and Fonte Boa there is a disproportionate emphasis on basic research and some could query whether Portugal can afford this luxury at the present time.

Certainly pasture-animal research involves integrated soil/plant/animal/socio-economic studies and the research not only has to be good but also relevant. This research must be designed so that it is amenable to both statistical and economic analysis. It is important for the research team to determine not only the ecological/biological possibilities but also the economic practicability of a particular system. The researchers must generate a range of options to cater for varying input levels of land, labour, capital, etc.

With regard to extension workers their advice must enable the farmer to make money, save money, or save work having regard to preserving a stable ecosystem.

III. SOME RESEARCH PRIORITIES FOR THE UNIVERSITY OF EVORA

These remarks will be confined to the existing and potential role of the agricultural school at Mitra. Ideally there should be Departments of Agronomy and Soils, Animal Science, and Agricultural Economics to have an effective interface with INIA and MACP and the rural community at large. Furthermore, staff at Mitra in these Departments must have the opportunity for research as well as teaching. While there is some merit in the present system requiring young staff to get the equivalent of a PhD in a few years this can be counter-productive in so far as Alentejo agriculture is concerned.

Research and extension staff working in the agricultural sciences must not lose sight of the fact that they should be working to help solve the rural problems faced by farmers and other tax-payers. The University of Evora staff at Mitra has an ideal opportunity to really help Alentejo agriculture but only if more staff are appointed to reduce some excessive teaching loads.

Some top priority research programs for the Agronomy Department staff and students and Animal Science Department using Mitra as a base are as follows:

(i) Grassland ecology surveys with Levy Point Quadrat or similar equipment.
Potential productivity of existing natural pastures and seed reserves.

(ii) Soils and land use: conventional tillage, minimum tillage and zero tillage and seedbed preparation options.
Soil physical problems and solutions.

(iii) Soil fertility and fertilizers: rotations.
Soil chemical problems and solutions.

(iv) Pasture and forage crop agronomy: pasture species, cultivars, mixtures, sowing rates, etc.

(v) Pasture management and utilization. Stocking rate influences. Pasture/animal interrelations. The importance of Y (Yield), U (Utilization) and E (Efficiency of conversion of feed into animal products).

(vi) Fodder conservation and supplementary feeding.

(vii) Cereal crop and miscellaneous crop production.

(viii) Horticultural crop and vine production.

Two of these, viz (i) and (ii) are most urgent as both involve the resource base (natural pastures and soils). It is essential that pasture surveys be undertaken to assess whether there is sufficient legume botanical composition and seed reserve to warrant top-dressing with superphosphate, and other fertilizers if needed, or whether the drilling in of clover seed plus fertilizer is needed to save the very expensive full cost of development i.e. ploughing, seedbed preparation, sowing seeds and fertilizers. (i.e. cost/benefit studies.)

The other serious problems is that of deep ploughing in the Alentejo and needs careful assessment by research and survey. Is it necessary? If so, where and why? Otherwise research and extension to substitute much cheaper soil preparation methods is urgent.

To enable much-needed research in pastures and forages at Mitra there will need to be a pasture/forage laboratory with cold room for holding green herbage samples, a large capacity forced-draught dehydrator with external vent for drying green herbage and associated balances and minor field and laboratory equipment. Ideally this work should not be done in the soil physical laboratory as there is insufficient room for both operations to be accommodated. A basic laboratory of about 10 m by 12 m with wide doorway accessible to vehicles for unloading is required. This pasture agronomy program will interact with both the soils and animal science research programs.

To allow teaching and research staff of the University of Evora to keep up to date with the literature, the library collection at Mitra needs strengthening. Useful additions would be as follows:

Proc. Australian Society of Animal Production
Proc. Australian Society of Agronomy
Jour. British Grassland Society.

IV. COOPERATION BETWEEN UNIVERSITY OF EVORA, INIA AND MACP

Close cooperation between UE, INIA and MACP must benefit Alentejo agriculture. While the Plant Improvement Station workers at Elvas are familiar with the problems of the Alentejo there is evidence that the research work at the National Agronomy Station, Oeiras, and the National Livestock Station, Fonte Boa, could with advantage take more account of the pressing agricultural problems of the Alentejo. However, at Fonte Boa and Oeiras there are keen young research workers anxious to help solve the agricultural problems of the Alentejo. It is essential that these young researchers be encouraged to help with these important field problems and be provided with adequate supervision, vehicles and per diem allowances.

A splendid example of a potential cooperative research site is the INIA station Herdade Revilheira which has excellent infrastructure for field research and first class accommodation for visiting researchers. However, at present this station is grossly underused for research despite the fact that it is only 48 km from Evora. This compares with the three University of Evora farms Almocreva - 85 km, Outeiro - 90 km and Daroeira - 105 km from Evora. Distance, travelling time, and available accommodation are vital components of field research. For this reason it would seem more appropriate for the three University of Evora farms to be used to generate income for research activities rather than spend money on developing accommodation and research infrastructure. However, all three farms appear to be over-capitalised so far as machinery and equipment is concerned and over-supplied with labour. Furthermore, if these farms are to generate income more autonomy is required by the farm manager to enable payment of overtime for completion of urgent farm tasks. For example, Almocreva had some potentially very good oat-vetch hay ruined for lack of baling at the correct stage. Farm Manager Garcia at Herdade Daroeira is an impressive manager and clearly a keen observer: he noted and proudly showed surface-sown wheat on his own farm which was almost as good as that sown on a very expensive traditional seedbed. However, Garcia was clearly despondent at administrative isolation from the decision-making process in Evora.

The Regional Directorate of Agriculture with headquarters in Evora is administratively responsible for extension in the Alentejo yet the staff exceeding 1200 are so busy collecting statistics and administering subsidies, etc., they they have little time for extension and demonstration plots on farms. This is a sad situation. However, Manuel Rente, Director of MACP, Alentejo Region, was enthusiastic about his staff helping with joint research projects. Clearly such a relationship would need some formalising so that each party in the cooperative venture is aware of his/her responsibility. Each cooperative research team would need a leader or liaison person to ensure coordination between the participating organizations, who would bring the participants together as required for formal discussions: he might then become the subject matter extension specialist to brief extension officers or farmers on the results as they become clear. A person like Pedro Silveira of the University of Evora would be ideal for such a challenging task.

Finally, the needs of the pasture-livestock sector in the Alentejo are great: The University of Evora, INIA (Elvas, Fonte Boa and Oeiras), MACP and the World Bank (PCAA) group in Evora have much to do and a great opportunity to achieve real success in cooperative research, development and extension programs. Each group has some special responsibilities but hopefully some of their resources can be diverted into cooperative research

programs to aid the Alentejo farmers. The University of Evora could well take the research responsibility for work on pasture survey, and methods of pasture establishment also tillage practice and rotations in cropping systems: these research programs are of top priority in the Alentejo and are ideal for teaching and demonstration of research techniques to students to get them interested in the agriculture of the Alentejo.

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APPENDIX A

(Copied as received from University of Evora)

WORKPLAN FOR A FORAGE SPECIALIST WITH EXPERIENCE IN MEDITERRANEAN CLIMATE FOR APRIL - MAY, 1982 AT UNIVERSITY OF ÉVORA - Feb.1982

I. Administrative Elements

A. Proposed Dates and Duration:
One month in April - May Period (after April 16).

B. Counterparts at U.E.:
Will work with Ermelinda Pinheiro and Pedro Silveira in Agronomy, Afonso de Almeida and Manuel Cancela de Abreu in Animal Science.

II. Description of Work

A. Problems:
With rising prices of animal products and land and the prospect of reduced subsidies of concentrates, increasing the productivity of pastures in the Alentejo is becoming an important issue. In Australia subterranean clover covers more than 20-30 million acres predominantly in marginal rainfall and low soil fertility regions. Sub. clover is becoming more common in Portugal. Sub. clover has several production

problems hence applied agronomic suggestions and research areas need to be identified. A research agenda for grasses to combine with sub. clover and for other legumes, which could succeed sub. clover in the poorer soils and marginal rainfall areas without irrigation need to be defined.

Another frequent complaint in the Alentejo is that hay technology needs to be improved. The harvest is often so late that the hay is really straw. Suggestions on harvesting methods and composition and of the advantages and disadvantages of hay or silage would also be useful.

B. Objectives

1. Define research agenda for
   a) sub. clover
   b) combination grasses
   c) hay technology and composition
   d) silage technology and composition
2. Improve UE collaboration with INIAP - Elvas forage program and MAP.
3. Citing of the original contract: "A forage agronomist skilled in the production, utilization and management of grassland crops". (p.41)

C. Specific Work

1. The consultant will visit farms in the Alentejo to evaluate forage production, hay and silage technology.
2. He will discuss research programs and priorities with UE Agronomy and Animal Science personnel working on forages.
3. He will visit the National Forage Program of INIAP in Elvas.
4. He will visit the World Bank program here in Évora and the PROCALFER program in Lisbon.
5. He will present a seminar and a final report to UE, including suggestions on the following topics:
   a) Hay technology suggestions -
      Mechanization
      Large bale
      Different sources
      Recommended research
      Integration with National Programs of Forage and Livestock at Elvas and Fonte Boa.

b) Silage recommendations

c) Forage and grass research needs for poorer soils and without irrigation -

i) anticipated problems with sub. clover
   (1) estrogen
   (2) micro-nutrients
   (3) diseases - nematodes

ii) feasibility of domestic seed production
   (1) technical problems
   (2) institutional problems

iii) Forages besides sub. clover for adverse climatic and soil conditions. What should the agronomic trials include? Where do they get the forages? Danger of importing diseases?

iiii) Grass combination - also for non-irrigated, poorer soil conditions.
Selection criteria?
Stages of evaluation?

d) Coordination of University of Évora agronomists and Animal Nutrition researchers with other agencies - especially the forage research unit at Elvas, the Animal Nutrition center at Fonte Boa and the Ministry of Agriculture regional branch at Évora.

6. If requested, he will present a seminar at INIAP - Elvas.

D. Output Expected

1. Two Seminars. Final Report and interaction with staff of UE and INIAP - Elvas on research priorities in forages.
2. Interaction with MAP and PROCALFER on more applied suggestions.
3. From this, more relevant applied research can be defined in this priority area for Alentejo agriculture.

E. Special Skills, Qualifications or Prior Experience

1. Substantial research experience in a Mediterranean climate including knowledge of and work with sub. clover.
2. Availability for one month in the April - May period (after April 16).
3. Experienced researcher.

4. Preferable - Knowledge of Portuguese or Spanish.

F. Work Schedule

1. Weeks I & II

   Discussions with UE faculty

   Farm Visits

   First visit to Forage Program - Elvas

   Classes in UE course on Pasture and Forage Technology

2. Week III

   Two seminars -

   First on Australian experience in forage research relevant to the Alentejo.

   Second on Research Priority Establishment for the Alentejo: Methods and Concrete Suggestions.

   (Some modification of these seminar topics by the individual consultant will undoubtedly be made).

3. Week IV

   Final Report

   Visit to PROCALFER Program in Lisbon.

   Seminar for the World Bank group in Évora.

APPENDIX B

ITINERARY: AUSTRALIA - PORTUGAL - AUSTRALIA MAY 8 - JUNE 6, 1982

(Including Main Organizations and Persons Contacted)

May 8 Departed Adelaide Airport 10.00 a.m. for Melbourne and boarded flight BA012 for London via Sydney, Brunei, Singapore and Muscat.

9 London - Libson on flight TAP453. Collected by Dr. John Sanders and booked in to Hotel Rex Lisbon for night after 45 hour trip.

10 Visited US AID Mission in Lisbon with Dr. Sanders: also visited Dr. Pereira da Silva, Director of INIA. Visited INIA National Agronomy Station at Oeiras with Dr. Sanders and Pedro Silveira (Agronomy Department, University of Evora). Had preliminary discussions with Mr. Almeida Alves on PROCALFER project also E. Menezes de Sequeira and Maria Delfina Lucas (Department of Soils) and J. Figueiredo de Marques, Department of Microbiology.

Departed Libson for Evora - examined hay in fields *en route*.

11 All day field trip to World Bank project area in Redondo district with Dr. John Sanders, Eng. Joaquim Dordio (in charge of the development project) and his PCAA staff, also Eng. Enrique Muslera and his Agencia de Desarrollo Ganadero staff (World Bank Project) based at Badajoz, Spain. Arrived back in Evora c. 11.00 p.m.

12 Visited University of Evora Mitra School of Agriculture Research Station for discussions with Ermelinda Pinheiro, Rosario Oliviera (Agronomy) Afonso de Almeida, Manuel Cancela de Abreu, Godinho Avo and others (Animal Science). Inspected laboratories at Mitra. Returned to Evora to meet Rector Prof. Ario Lobo Azevedo and Prof. E. Cruz de Carvalho.

13 With Dr. Sanders to see and discuss improved pastures and beef production on farm of Jorig and Carolina van Voorst at Herdade de Zambujeira near Evora.

14 With Dr. Sanders, Helena Estudente and Eng. Banza, visited and inspected the University of Evora farms Herdade Almocreva and Herdade Outeiro.

15 Visited Herdade Quinta das Atafonas with Pedro Silveira to see the Holstein dairy enterprise and improved pastures of various ages. Reading reports in afternoon.

16 Reading reports and preparing for first seminar. Sorting slides for seminars at Mitra and elsewhere.

May 17 Presented Seminar No. 1 at Mitra on subject: *The southern Australian Experience in Forage Production and Research Relevant to the Alentejo.*

Discussions with Rector Azevedo over lunch and continuing.

Inspected EIPO Stocking Rate Experiment with Joaquim Casquinha and Rosario Oliveira then inspected the Rhizatron facilities with Rosario, who is in charge of this facility and the Soils Laboratory.

18 Departed 7.00 a.m. for INIA Research Station (Herdade Revilheira) Reguengos de Monsaraz with Rector Azevedo, John Sanders, Pedro Silveira, Afonso Almeida, Manuel Cancelo de Abreu for on-site discussions and inspections with the Director of INIA (Dr. Pereira da Silva) and station staff.

Visited FAO Alentejo Soil Conservation and Drainage Project headquarters at Evora for discussions with Dr. I. Abu Sharr (Leader) and local staff.

19 Departed 7.30 a.m. for Elvas with Dr. Sanders, Pedro Silveira and Ermelinda Pinheiro and spent day at INIA Plant Improvement Station and saw both irrigated and rainfed pastures in the district with Eng. David Crespo and his colleagues in the pasture/forage group. Re-looked at the oldest stocking rate experiment in Portugal (first seen in 1974).

Obtained Spanish Visa for visit to Badajoz area.

20 With David Crespo to meet with Director José Barbas Guerra of the INIA Elvas station prior to visiting the field to see pastures sown to subterranean clover for various periods.

Presented Seminar No. 2 at the Plant Improvement Station Elvas on the topic: *The Importance and the Management of Rainfed Pastures in the Alentejo.* Further inspection of Elvas district with David Crespo and José Barbas Guerra.

21 From Elvas with Dr. Sanders, Pedro Silveira, Ermelinda Pinheiro and David Crespo to Badajoz and on to the Spanish INIA Station - Finca La Orden. Discussions with Director at La Orden (Dr. Mariano Mora) and saw legume research program with Dr. Miguel Granda, Carlos Gomez, Victor Moreno, Alvaro Ramos Monreal and Leopoldo Olea. With Enrique Muslera and Manuel Flores (AGENCIA) to see various pastures sown under the World Bank Development Program in the Badajoz region of Spain.

22 Departed Elvas with David Crespo and collected John Sanders at Evora thence to Herdade Vale de Arca - large farm with Friesian milking unit based on irrigated pasture and corn/sorghum silage, beef fattening unit, German Merino and local Merino flocks and other farm enterprises. Inspection and discussion on pasture improvement program.

23 Reading reports and preparing for next seminar.

May 24 Departed 7.30 for Beja region with Dr. Sanders and Maria Helena Estudente to see University Farms (Herdade Outeiro and Herdade Daroeira) in Beja region. Eng. Jose Banza showed and discussed land use in this region and towards coast at v.d. Milfontes. Inspected farms of Eng. Banza and Joaquim Nunes Garcia (Manager of Herdade Daroeira - the Rice Farm). Arrived back at Elvas at 10.30 p.m.

25 Departed 7.30 a.m. for the INIA National Livestock Station "Fonte Boa" at Vale de Santarem with Dr. Sanders, Pedro Silveira and Francisco Ramos (Rural Extension Department), Afonso de Almeida and Ermelinda Pinheiro. Excellent program of inspection organized by Dr. Joao Ramalho Ribeiro, Head of the Nutrition Department on Fonte Boa.

Presented Seminar No. 3 on topic: *Pasture Production and Management with Special Reference to the Alentejo.*

26 With Dr. Sanders, Pedro Silveira and Ermelinda Pinheiro to see pasture development and general land use on the sandy soils of the Pegoes, Palma and Porches region. Discussions with Director of Agriculture of Ribatejo Oeste (Jose Francisco Chicau), Director of Sub-region of Setabul (Francisco Moniz Borba), André Dordio, Teodosio Salgueiro and others. Visited Pegoes Experiment Station and the private farms of Joa Posser de Andrade at Palma (acid sands) and Jose Bustorff Silva on coastal calcareous soils near Setabul.

27 Presented Seminar No. 4 (10 - 12.40 p.m.) at Mitra on the subject: *Stocking Rate and the Ecosystem: the Need for Collaboration between Soil/Plant/Animal and Economic Research Workers.* Further discussions over lunch with Prof. Carlos Portas.

With Pedro Silveira to see World Bank PCAA Group (staff of Eng. Dordio) to inspect clover seed production areas and also Shearer scarifier and drill, clover seed inoculation facilities in Elvas region of Fund Fomento Forestal.

28 With Dr. Sanders and Prof. Mariano Feio (geographer) to see University farms Daroeira and Outeiro in Beja Region.

29 Reading reports and writing at home all day. Preparing for next seminar at Mitra.

Dinner and evening discussions at home of Dennis Sims (FAO project).

30 Reading and writing: preparing next seminar.

31 Presented Seminar No. 5 at Mitra on topic: *Research and Extension Suggestions for Pastures and Forages in the Alentejo.* (10 a.m. to 1 p.m.). Lunch at Convent with Rector Azevedo and pasture/forage research workers of Portugal. From 3 - 6 p.m. led detailed discussion period involving UE, INIA and other pasture-animal research and development, also extension, workers of Portugal. Met with Ermelinda Pinheiro, Pedro Silveira and Rosario Oliviera from 6 - 6.30 p.m. to briefly discuss their research programs.

June 1 Discussion with Rector Azevedo and Eng. Mario de Carvalho on proposed tillage/rotation research program. Lunch and further discussion with Rector, Dr. Sanders and Pedro Silveira.
3 p.m. Discussions with Carlos Silva Carvalho on Australian and other sowing and tillage implements.

With Dr. Sanders and Pedro Silveira to meet Regional Director of Agriculture (MACP) for the Alentejo, Manuel Joachim da Silva Rente.

Departed Elvas for Lisbon 9.30 p.m. arriving 12.00 midnight.

2 9.00 a.m. Meeting with Dr. Pereira da Silva, Head of INIA.
11.00 Meeting with Mr. Donald Finberg and Mr. Charles Buchanan Jr. and other US AID Personnel.

3.30 p.m. Presented Seminar No. 6 to Agricultural Systems class at the University Agronomy School, Lisbon on the subject: *The Role of Legume Pastures in Farming Systems in the Mediterranean Pasture Areas of southern Australia.*

6.00 Discussions with Eng. Almeida Alves, Coordinator of the PROCALFER Project at the National Agronomy Station, Oeiras.

3 9.30 a.m. With Pedro Silveira to see the land use and soil mapping group in Lisbon to seek information on land use planning.

Luncheon meeting and discussions with Dr. John Sanders and Pedro Silveira.

1.45 p.m. Collected from Hotel Rex by Eng. Andre Dordio, President of the Portuguese Pasture and Forage Society to address meeting of this Society at the National Agronomy Station, Oeiras, on the topic: *Mediterranean Pastures* (Seminar No. 7).

Inspected Oeiras farm and saw some of coastal land use and ecology. Further discussions with Andre Dordio and Pedro Silveira over dinner.

4 Sorting Australian reprints and information, etc. to leave for staff of University of Evora.

Final discussions with Dr. Sanders and Pedro Silveira and departed on Lufthansa Flight LH201 from Lisbon at 4 p.m. for Frankfurt, then LH668 for Hongkong.

5 Boarded Qantas flight QF028 at Hongkong for Melbourne at 21.30 hr. changing to TN028 at 12.10 hr for Adelaide.

6 Arrived home in Adelaide in afternoon after a 40-hour trip from Lisbon.