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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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PORTUGAL UNIVERSITY INSTITUTES DEVELOPMENT PROJECT

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REPORT ON

SHORT-TERM STAFF ASSIGNMENT

at the

Universidade de Evora
Evora, Portugal

April 15 - May 16, 1983

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PREFACE

This report on my 1983 short-term assignment under the Purdue University Portugal University Institutes Development Project builds on foundations laid during my first assignment from May 8 - June 6, 1982, and the report on that visit.

The background and terms of reference for the 1983 assignment are shown in Appendix A. I was given permission to be absent from my University during the period April 15 to May 16, 1983 and my itinerary in Portugal is detailed in Appendix B. Once again, there was a heavy load of field and laboratory visiting and consultation with many individuals and groups in Portugal, not only in the Alentejo (principally at the University of Evora) but also at the Instituto Universitario de Tras-os-Montes e Alto Douro at Vila Real and surrounding districts. Furthermore, I was fortunate to attend the spring meeting of the Portuguese Society of Pastures and Forages at Curia with the associated field visiting. This extensive travel gave me a clear picture of the existing and potential land use and some of the related agronomic, economic and social problems of these regions of Portugal. There is overwhelming evidence of the potential to improve production of pastures and forage crops.

Definitions of pasture, rangeland, forage crop and fodder were given in the report on the 1982 assignment and will not be repeated here.

The main emphasis of the 1983 assignment was:

(i) to encourage interest and promote greater awareness of the potential to increase the quantity and quality of pastures and forage crops with particular emphasis on the role of annual legume species;

(ii) to indicate some of the standard research and development techniques to improve the quantity and quality of pastures and forage crops with the emphasis on maximising benefits and minimising costs;

(iii) to emphasise the importance of ensuring reasonable levels of utilization of pastures and forage crops by ruminant livestock; and

(iv) to stabilize ruminant livestock production by having adequate reserves of conserved fodder - most conveniently as small hay bales for normal handling.

In Portugal there is adequate labour at reasonable rates and a general deficit of mechanical handling equipment so there is no justification for making large bales of hay or straw on most farms.

The most concentrated component of my assignment was the Pasture and Forage Crop Workshop sponsored jointly by the University of Evora and PROCALFER. The report on this workshop forms the basis of the 1983 report but it does not encompass all aspects of my assignment.

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 all those persons listed in the Itinerary, and any who 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; Eng. Pedro Silveira and his wife Carmo for arranging the detailed itinerary and for their guidance and friendship at Evora and elsewhere; Eng. Pedro Vacas Carvalho, Dr. Afonso de Almeida and Dr. Manuel Cancela d'Abreu.

Finally, it is a pleasure to record my thanks to the US AID Mission in Lisbon and to Purdue University for providing financial assistance to enable me to undertake this assignment in Portugal which is so closely related to my research and teaching at the University of Adelaide in South Australia.

Edward D. Carter

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10/8/83

REPORT ON PASTURE AND FORAGE CROP WORKSHOP, UNIVERSITY OF EVORA.

HERDADE DA MITRA, MAY 2-6, 1983

I. INTRODUCTION

1. The workshop was arranged for staff and senior students of the University of Evora, MACP regional staff involved in the PROCALFER program and any other interested technical staff from related organizations including INIAER, and Lisbon staff of D.G. Agriculture and D.G. Forestry. The workshop was jointly convened by Eng. Pedro Silveira, University of Evora, and Eng. Andre Dordio of INIAER who is coordinating the Regional PROCALFER pasture and forage testing program. The workshop comprising eight working sessions commenced at 2.30 p.m. on May 2 and finished at 1.00 p.m. on May 6. Details of the program are shown in the following pages.

2. The object of the lectures, discussion, field work and laboratory work was to introduce new philosophies, new ideas, new techniques and hopefully inspire new vigour and resolution in integrated soil-plant-animal-economic research and development and extension related particularly to the production and utilization of pastures and forages in Portugal.

3. Numbers of participants varied from 20 to 60 depending on whether the senior students at Mitra were able to attend and depending on a variable number of visiting participants. Unfortunately the time clash with the Sheep Exposition and Fair at TOMAR (May 5-8) made some inroads on numbers on May 5-6. Average attendance over the five-day period of participants from the seven Regional Directorates of Agriculture were as follows: (1) Entre Douro e Minho = 4.0; (2) Tras-os-Montes = 2.4; (3) Beira Litoral = 0.0; (4) Beira Interior = 1.0; (5) Ribatejo e Oeste = 2.2; (6) Alentejo = 2.4; (7) Algarve = 0.0. The non-attendance of PROCALFER program workers from Beira Litoral and Algarve is regrettable and highlights the inevitable problem of divided responsibility between INIAER Coordinating Officers and MACP Administrative Officers. Such division of responsibility does not ensure effective use of PROCALFER funds in improving pasture and forage crop production in Portugal. In view of the current poor standard of pasture and forage crop production and management, grazing management, and fodder conservation in the Alentejo and despite the obvious dependence on livestock enterprises for economic viability in future, the poor attendance of staff from the Regional Directorate of Agriculture at Evora is lamentable. It is to be hoped that the availability of only 2 or 3 staff members from this Region to attend the workshop does not reflect satisfaction with the present productivity of pastures and forages in the Alentejo.

4. While it is impossible to reproduce all features and discussion at the workshop where some 300 slides and transparencies were used the following sections II, III, IV, V and VI summarize the activities of the eight sessions spread over the five days.

UNIVERSITY OF EVORA AND PROCALFER PASTURE AND FORAGE CROP WORKSHOP

University of Evora, Herdade da Mitra, Valverde

Date	Time	Program Detail
May 2	14:30 to 18:00	. Introduction . Methods of assessing pasture yield and botanical composition. Use of Levy Point Quadrat for pasture surveys and Soil Corer for sampling legume seed reserves.
May 3	09:30 to 13:00	. Methods of land development and pasture improvement relevant to Portugal. . The three main options for pasture improvement in rainfed areas of the Alentejo and elsewhere in Portugal.
	14:30 to 18:00	. Choice of pasture species, cultivars and mixtures especially for rainfed pastures. . Methods of pasture establishment. Seedbed preparation. Sowing methods and equipment. . Pasture management: fertilizers, mowing, etc. . Grazing management at green pasture stage and dry pasture stage. Problems of undergrazing and overgrazing. . Grazing management: specific effects of the grazing animal - treading, defoliation, recycling of nutrients and dispersal of seed.
May 4	09:30 to 12:30	. Examination and discussion of tillage and sowing equipment at Mitra. . Examination and discussion of the EIPO grazing experiment at Mitra. Taking soil cores for measuring legume seed reserves.
	13:30 to 21:00	. Visit to Vale Formosa to see stocking rate experiment and PROCALFER species and fertilizer experiments.
May 5	09:30 to 13:00	. Detailed instruction and discussion of experimental procedures for evaluation of pastures and forage crops, e.g. forage crops like oats; subterranean clover cultivars; fertilizer experiments. Note: During discussion of fertilizer experiments, Eugenio Sequeira of INIAER at OIERAS showed slides of some of his research results on micronutrients in pot culture studies.
	14:30 to 18:00	. Grazing experiments - especially stocking rate experiments and the special needs for soil, plant and animal data collection.
May 6	09:30 to 13:00	. General discussion on experimental techniques.

II. SUMMARY OF WORKSHOP PROGRAM - MAY 2, 1983

1. Measuring Yield and Botanical Composition

A. Ungrazed Experiments (Pastures and Forage Crops)

(1) Selection of sampling sites - systematic or complete randomisation.

(2) Frequency of sampling - 2 to 4 weeks during green stage.

(3) Shape and size of quadrat samples - edge errors.

(4) Height of cutting - related to species recovery, also special problems f assessing differences between fertilizers and differences in winter production.

(5) Cutting equipment - scalpels to forage harvesters depending on size and scale of the experiment.

B. Briefly-grazed Experiments (Forage Crops for grazing or hay, e.g. oats/vetch)

(1) Sample at given height (say 3 to 5 cm).

(2) Graze down rapidly to this height with fasted sheep as quickly as possible and remove sheep at night to avoid camping effects (deposition of faeces and urine).

(3) Repeat procedure through season as required.

(4) Ignore growth during period of rapid grazing in assessing relative yields.

(5) Discontinue grazing and cut for hay or reap for grain as required.

C. Continuously-grazed Experiments (Pastures)

(1) Use 'open' and 'closed' quadrat techniques for assessing pasture availability and cumulative pasture growth (yield) through the season.

(2) 'Divide' each paddock into say 10 strata for all sampling operations.

(3) Sample at random within each stratum.

(4) Bulk the samples from two or more strata, if needed, to reduce work.

2. Field and Laboratory Procedures for Workshop Participants

(1) Each person to use Levy Point Quadrat (Tiver and Crocker, 1951) and record vegetative hits made by point of needle as it descends through the sward. One frame = 10 points. Record legumes, grasses and other species also bare ground (including dry herbage residue or moss). Numbers 1 to 10 allocated to observers.

(2) Cut a 25 x 40 cm quadrat sample of the pasture to ground level from same site as pointing. Place herbage in numbered plastic bag corresponding to Levy Point Quadrat (LPQ) data.

(3) Estimate on laboratory bench the percentage legume, grass and other species on basis of allocating 10 points each to 10 equal heaps of herbage from each of the numbered field samples.

(4) Hand-separate field samples into legumes, grasses and other species and packet for drying and weighing using numbered packets.

(5) See data on three methods of determining botanical composition, total vegetative hits and also total dry matter on class sheets. It should be noted that yield of dry matter is correlated with total vegetative hits by LPQ method. Also LPQ and Lab Estimates of botanical composition should be correlated with the data on botanical composition obtained from the hand-separations of the herbage samples.

3. Measuring Legume Seed Reserves
(after cereal crops in 'pousio', natural pastures and native pastures).

(1) Take core samples 10-15 cm diameter and 5 cm deep in September to assess total legume seed reserve that may emerge depending on moisture content and soil texture. Dry at 50°C.

(2) Dry-sieve using 1.00 mm sieve to retain seed of subterranean clover and 0.5 to 0.75 mm sieve to retain small seeded *Trifolium* species (e.g. *T. glomeratum*) and *Medicago spp*.

(3) Pass residues into perchloroethylene (SG 1.62) to separate seed and organic residue from soil and stones (Carter, Challis and Ridgway, 1977).

(4) Dry samples in sun or under fume-hood then hand-separate, count and weigh to give legume seed number and weight per unit area. To remove bias all weighings should be done at the same time for any particular experiment or regional survey. The seeds need time to adjust to ambient temperature and humidity.

(5) Repeat this procedure in March to give data on hard seed reserves in the soil prior to commencement of seed maturation of currently-growing legumes.

(6) Seed harvest data coupled with data on total seed reserves, total emergence and hard seed reserves allows a complete seed budget to be prepared for the grazed pasture.

Note(1): Workshop participants noted the legume seed reserves obtained from the EIPO grazing experiment and from a deep-ploughed area at Mitra and participated in taking 10 samples each comprising 3 cores from treatments 3C, 6C and 12C on the EIPO experiment on Wednesday May 4.

Note(2): South Australian data on annual medics shows that in any year approximately 30% of total seed reserve germinates, about 20% emerges but often only about 10% becomes established hence the need for large legume seed reserves.

III. SUMMARY OF WORKSHOP PROGRAM - MAY 3, 1983

1. Land Development and Pasture Improvement

(1) Whether the pasture is developed from forest or scrub or savannah woodlands (oaks in Portugal or eucalypts in Australia) with an understorey of native pastures the objective should be legume-based pasture. Aim for maximum legume at least cost. Pasture legumes in Australia are worth $2500 million per year through the huge contribution to the quantity and quality of livestock feed and improved soil fertility through nitrogen accretion (Carter, 1981).

(2) The three options in pasture improvement for the Alentejo are:

(a) If sufficient legume, apply superphosphate with micronutrients as needed. Lime and/or patassium may also be required.

(b) If some legume, use superphosphate with micronutrients as required, plus legume seed mixture drilled in before the opening rains. Lime and potassium may also be required.

(c) If only a trace of legume: e.g. old wheat crop areas and if areas are very weedy prepare a seed bed and kill weeds after the opening rains and sow legume seed mixture with superphosphate and micronutrients as required. Lime and potassium may be required. Herbicides like ICI 'Sprayseed' or Monsanto 'Roundup' are particularly useful in these situations.

2. Choice of Pasture Species

(1) Emphasis must be on legumes: little need for sown grasses in rainfed pastures of the Alentejo (plenty of spontaneous grasses and weeds).

(2) Existing legumes in native or natural pastures may be identical to commercial cultivars, or slightly better, or slightly worse. However, if present, legumes should be encouraged - hence need for dry tillage and sowing operations.

(3) Good native/natural pastures in the Alentejo include:

Trifolium subterraneum
" *glomeratum* and many other *Trifolium* spp.
" *resupinatum*
Medicago polymorpha and many other *Medicago* spp.
" *arabica*
Ornithopus compressus
Lupinus spp.
Vicia spp.

and many other legumes. The above species should form the basis of any seeds mixture.

(4) Choice of legumes should be for persistence and production both of which are related to total seed and hard seed production and reserves in the soil. A range of cultivars and species should be used to fill all ecological niches and set seed under the worst conditions. Seed production ensures plant density which leads to winter production, and winter production determines year-round carrying capacity.

(5) Important features of subterranean clover are as follows:

Cultivar	Days to flower when sown in May at Perth*	Rel. Hard-Seededness 1 - 10 Low High	Rel. Resistance to *Kabatiella* 1 - 10 Low High
Nungarin	78	10	1
Northam	83	7	1
Daliak	100	5	9
Seaton Park	114	5	1
Trikkala	116	2	4
Woogenellup	134	3	1
Clare	135	1	2

* Flowering takes a little longer at Adelaide and probably also at Evora but the relative ranking is unlikely to be changed.

Nungarin or Northam should be included in all seeds mixtures for the Alentejo where conditions suit subterranean clover. Daliak should be in all mixtures, Seaton Park in all mixtures except where there are known problems of *Kabatiella* (Clover scorch). Trikkala should be in all mixtures where significant areas are subject to seasonal waterlogging. Woogenellup is a useful later-maturing cultivar though it is not a prolific seed-setter and a high proportion of burr form above ground which is a disadvantage. It is also quite susceptible to clover scorch disease. The Clare cultivar is the only one suitable for neutral to alkaline soils. Though having better resistance to clover scorch than Woogenellup, it is not so well adapted to heavy grazing as is Woogenellup. As *Kabatiella* is most troublesome in the dark humid conditions of tall (under-grazed) swards, reasonable grazing pressure will minimize the incidence of this disease.

(6) Some examples of suitable seeds mixtures (kg/ha) for the Alentejo assuming no existing legumes are as follows:

(a) Granitic and Schistose Soils - drier phase with rocky, shallow soils but with some wet depressions: Nungarin 2 kg, Daliak 4 kg, Seaton Park 3 kg, Trikkala 1 kg, Woogenellup 1 kg, Clare 1 kg, *Ornithopus compressus* 1 kg, *Trifolium respuinatum* cv. Marral 0.5 kg, *Trifolium glomeratum* 0.5 kg, *Dactylis glomerata* cv. Currie 1 kg.

(b) Granitic and Schistose Soils - wetter phase with mixed soil depths and drainage. Northam 2 kg, Daliak 3 kg, Seaton Park 3 kg, Trikkala 2 kg, Woogenellup 1 kg, Clare 1 kg, *Ornithopus compressus* 1 kg, *Trifolium resupinatum* cv. Marral 0.5 kg, *Trifolium glomeratum* 0.5 kg, *Dactylis glomerata* cv. Currie 1 kg.

(c) Deep sands (e.g. Pegoes). In the deep sands, sowing at 3-4 cm depth is desirable. Typical sowing rates per hectare are as follows:

(1) Lime-banded alfalfa as special purpose pasture/forage crop 5-10 kg.

(2) Nungarin or Northam 2 kg, Daliak 4 kg, Seaton Park 4 kg, *Ornithopus compressus* 4 kg, *Phalaris tuberosa* 0.5 kg, *Erharta calycina* 0.5 kg.

Note(1): Where legumes are being sown dry into an existing legume-rich area it will usually not be necessary to sow *Ornithopus*, *T. resupinatum* or *T. glomeratum*.

Note(2): Very wet swampy areas should receive special treatment at sowing. *Trifolium fragiferum* and/or *Trifolium pratense* and/or *Trifolium repens* may be sown with advantage in permanent pasture areas.

3. Methods of Establishment

(1) Any expense on seeds and fertilizers is doomed to failure without proper attention to method of establishment.

(2) Poor crop and pasture establishment in Portugal reflects the disastrously-deep ploughing and subsequent poor seedbed preparation. Deep ploughing is incompatible with pasture improvement for a pasture-livestock-crop farming system because legume seed is buried too deep to allow regeneration after the cereal crop.

(3) The essential feature of any method of pasture or forage crop establishment is to ensure that seed is placed at the correct depth in the soil and that there is good seed-soil contact to ensure adequate water exchange for germination. Depth of sowing is ideally < 1.0 cm except in deep sands with excessive drainage when sowing at 3 to 4 cm is usually required.

(4) Tyned drills, disc-drills and disc sod-seeders are the ideal sowing implements for broadscale sowing. Sowing in rows can reduce seed and fertilizer requirements for establishment. A 500-600 kg/ha rate of broadcast single superphosphate may well be reduced to 300-400 kg if sown in rows and give the same growth of first-year pasture. Likewise the 15 kg/ha seed mixtures indicated under III. 2 (6) may well be reduced from 15 kg to 10 kg per hectare. Thus with better placement considerable savings on fertilizer and seed in the year of sowing are possible. The standard 15-18 cm row spacing is generally better for pastures and forage crops than are wider spacings, e.g. 25 cm used on some machines. There is too much weed competition in Portugal for best results from the wider spacings. On the other hand, narrow row spacing, e.g. 9cm is unsuitable in most of Portugal because of stones in the soils being sown to pastures. However, in the absence of obstructions the narrow row spacings give excellent results in crop and pasture establishment. Roller drills (e.g. Brillon) and rolling after sowing should be avoided unless the soil is dry and loose, e.g. sandy soils. Much more use should be made of light covering harrows (none seen in Portugal) or simply dragging boughs of trees, or bushes to follow all contours and cover the seed.

(5) Essential Features of 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 (Carter, 1974). These are as follows:

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

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

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

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

(e) 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 commonly 45-50 cm and disc or tyne clearance 30-45 cm.

4. Pasture Management

(1) Fertilizers: Much more research is needed to identify various nutrient responses, the fertilizer requirements for pasture establishment and the maintenance requirements of fertilizers in the various regions of Portugal. There is no point in applying fertilizers to grow more herbage if there are insufficient grazing animals to utilise the pasture or forage crops.

(2) There are widespread symptoms of molybdenum deficiency in subterranean clover in Tras-os-Montes, Beira Litoral, Beira Interior, Ribatejo e Oeste and the Alentejo (the writer has not seen the Entre Douro e Minho or Algarve Regions). There are less widespread symptoms of copper and zinc deficiency in subterranean clover. However, it should be stated that most of the subterranean clover seen had recovered from extreme drought and this could have affected metabolism and development of symptoms of molybdenum, copper and zinc deficiency. There are symptoms of boron deficiency also in several *Trifolium* species but these were not widespread.

(3) The relative importance of lime to raise soil pH, improve nodulation (both plant and *Rhizobium* are involved) and generally improve establishment of legumes and other genera (calcium as a nutrient) needs urgent evaluation by careful experimentation in the field and laboratory. There is no doubt that lime has given responses to several species including pasture legumes but unless

molybdenum is used as a control the results must remain in doubt. There is little doubt that some apparent responses to lime are in fact a molybdenum response through mobilization of molybdenum at the higher pH achieved by liming. There is urgent need for field experiments involving surface liming and incorporated lime at say 2000 kg/ha versus lime banding of legume seeds using 200 kg/ha along with a control with no lime, all with a plus and minus molybdenum treatment, i.e. a minimum of eight treatments. The crushing, fine-grinding, transport and spreading of lime is expensive. It is urgent that some more definitive research be done to clarify these issues.

(4) Mowing and slashing to control weeds is essential for assisting development of new pastures especially in the absence of large numbers of sheep to enable rapid heavy grazing of new pastures. However, rough seed beds in many parts of Portugal are a major constraint to mowing and slashing operations even with 3-point linkage rotary mowers and slashers.

(5) Spreading manure: On irrigated pastures and high-producing rainfed pastures there is a great need for pasture harrows to spread cattle dung to prevent the development of areas of rank pasture which are avoided by the grazing animal.

(6) Herbicide spraying or the use of rope-wick type units with contact herbicides for eliminating taller weeds in sown pastures have a role in many areas of Portugal.

(7) Insecticide use: As with fertilizers, there is no point in spraying or dusting to control insect pests of pastures or forage crops to gain extra production unless the extra feed is needed to feed livestock. However, insect control may be needed to ensure survival of newly-sown pastures or forage crops (e.g. alfalfa).

5. Grazing Management - General

(1) On annual pastures after the opening rains the aim should be to reduce the grazed area by feeding out hay, etc. on as small an area as possible, i.e. a 'sacrifice paddock'. This will allow pastures to produce leaf area and increase growth before the colder, winter weather. The sacrifice paddock is tilled and sown to a summer forage crop (e.g. Sudan grass, Japanese millet or chou moullier) if sufficient spring rain, alternatively prepared for re-sowing to pasture in the following autumn.

(2) Once all hay (or other conserved fodder) is fed out the grazing animals should be spread over the whole farm to minimize grazing pressure. Ewes with lambs should be set-stocked.

(3) After lambs are weaned, ewes are aggregated onto smaller areas to allow paddocks to be reserved for hay. Sheep (and cattle) can be moved to control weeds by concentrating the livestock on small areas. This highlights the need for fencing, which is also necessary for disease control.

(4) For newly-established legume pastures it is best to continuously graze through the season, keeping height of sward between 4 and 8 cm to maximise flowering in subterranean clovers and annual medics, then reduce grazing pressure to maximise seed production.

(5) After seed maturity, excessive top growth of clovers or medics must be grazed off to avoid a 'blanketing effect' should unseasonal rain fall. However, the grazing of pods and burrs on newly-established legume pastures must be avoided. On older pastures with adequate seed reserves then pods and burrs are good feed in summer and autumn. However, almost all seed of subterranean clover that is ingested by sheep is destroyed and 95-98% of medic seed ingested by sheep is also destroyed (Carter 1980, 1981, 1982).

IV. SUMMARY OF WORKSHOP PROGRAM - MAY 5, 1983*

1. Grazing Management - Effects of Grazing Animal

(1) Treading: This may be a problem on wet soils (poaching of the pasture and pugging of the soil) and on sandy soils (wind erosion). The technique of D.B. Edmond (N.Z.) and E.D. Carter (South Australia) in passing nd sheep through a race of effective width of 147 cm every d days to simulate the treading pressure of n sheep/ha was shown on slides. This technique is good for ranking species and cultivars for treading resistance but it is rapid and severe analogous to mowing versus defoliation by the grazing animal. Both annual and perennial *Lolium* spp. resist treading better than annual or perennial *Trifolium* species.

(2) Defoliation: If there is *ad libitum* pasture availability there is selection within and between plants - green leaf being eaten before green stem before dry leaf and dry stem. However, in well grazed Mediterranean annual pastures all feed is consumed in summer and autumn so selection based on palatibility is a temporary phase during the season. Grazing pressure can be used to advantage to control weeds or change botanical composition. In a mixed grass-legume sward grazing pressure has more influence on botanical composition than does the initial seeds mixture. Larger animals cannot prehend feed as well as smaller animals hence cattle and horse paddocks are more weedy than areas grazed by sheep.

(3) Recycling of nutrients by the grazing animal changes plant nutrient status by vertical transfer of nutrients from plant to soil, also horizontal transfer of nutrients, e.g. when sheep and cattle are taken from pastures at night. Excessive transfer of nutrients from the fields to the night-holding areas occurs in Portugal. Similarly there is nutrient transfer by animals to shade areas (e.g. oaks) and shelter areas. Most of the readily-available Ca and P are in the faeces of grazing ruminants+. Thus a response by clover to a urine patch may mean a K response. On molybdenum-deficient soils it may also be a response to N. A grass response

+ and N and K mainly in the urine

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* The field visiting on May 4 is presented later to give better continuity.

to a urine patch is generally a response to N. it is important to watch for these signs.

(4) Influence on seed supply and transfer: Most grass seeds are readily digested but many hard-seeded legume seeds are distributed in livestock droppings. Although sheep may seriously reduce the number of viable seeds following ingestion a greater percentage of legume seeds survive passage through cattle. Seed is also transported by attachment to the hair or wool of grazing animals.

2. Fodder Conservation and Supplementary Feeding

(1) As stocking rate is increased, better management of livestock is needed, more supplementary feed is required but the opportunity for fodder conservation decreases. Buying-in hay may be economic but the hay may also bring in new and serious weeds.

(2) Hay should be the dominant form of conserved fodder in most of southern Portugal as hay-making weather is generally good. However, there is an urgent need to cut hay at an earlier stage of maturity to increase crude protein and digestibility. Cutting earlier will also help to control weeds. The small bales are likely to continue to be the most useful: labour is plentiful and equipment for handling large bales is too expensive for most farmers.

(3) There are some obvious problems in hay making. Firstly, in many cases the gound is too rough for good haymaking - hence loss of potential yield and also excessive breakdown of machinery. There is a good deal of unsuitable haymaking equipment. Weather forecasts are inadequate for rural districts. Finally, there is no price incentive for good hay. These matters can and should be rectified.

(4) In the Alentejo it is certainly possible to make good early-cut hay in three or four days as follows:

Day 1: Cut with mower and pass swathe through conditioner (one stage or two-stage operation).

Day 2: Rake

Day 3: Bale

or Day 3: Possibly turn if very high-yielding cut

Day 4: Bale " " " "

Depending on weather and bale-density, carting and stacking may proceed from day 4 or day 5.

3. Experimental Procedures - Evaluating Oat Cultivars

Problem: Assume existing standard oat cultivar in a district is A. Evaluate 7 new cultivars of oats for winter grazing and subsequent hay/grain yield.

(1) Select site or sites on basis of access and uniformity.

(2) Check germination and purity of all cultivars to ensure that all are sown at the same rate of pure germinating seed. Use fungicide dressing if required.

(3) Assume randomised block design (4 blocks) and sown with tractor and trailed drill of 2-3 m sowing width. Need four sets of letter pegs (A-H), four sets of marker pegs and sighter pegs (alternatively two assistants with moveable sighter pegs) for ensuring straight drill rows. All pegs should be painted white. Letter pegs and marker pegs are ideally 50 x 20 mm hardwood x 600 mm long. Sighter pegs are ideally 25 x 25 mm x 1500 mm long.

(4) Plots on one block used as the starting point are in alphabetical order: on the other three blocks cultivars are at random. Old paint brushes and wire prodders are needed to ensure that the drill is completely cleaned between cultivars. It is also necessary to wind seed-sowing mechanism on the drill to ensure full-flow of seed by the time the drill reaches the start of plot. The same procedure may be needed for fertilizers.

(5) The sampling for dry matter yield, involves making autoscythe cuts (4 or 6) across the plots. (Alternatively take quadrat samples.) Height of the cutter bar is regulated by special skids. Samples along each plot can be bulked and subsampled to give a green sample of 1-2 kg for drying.

(6) After sampling to a fixed height of 3-5 cm graze down rapidly with fasted sheep to this level. Remove sheep at night if grazing for more than one day to avoid camping effects. Ignore growth during grazing period. Repeat grazing as required.

(7) Sample at hay stage (milk to early dough stage of grain) using above methods.

(8) Sample grain at harvest time by hand using fixed length of row - say 10 lots of 3 metres spread across the plot but avoiding the outside rows. Alternatively reap whole plot, omitting outside rows if possible, if small combine harvester is available.

4. Experimental Procedures - Evaluating Cultivars of Subterranean Clover

(1) Select site (or sites) on the basis of access and uniformity.

(2) Assume a hand-sown randomised block sward experiment.

(3) Check germination and purity of seed samples and sow on the basis of equivalent pure germinating seed.

(4) In small plot experiments with plots say 2 m x 5 m it is very useful to have pre-placed quadrats positioned immediately after sowing. For example 18 x 0.1 m^2 quadrats can be placed on a 1.8 m x 4.5 m plot allowing two groups of 9 random harvest sites to be used. Space between the wire quadrats must be a minimum of 25 or 30 cm (i.e. at least as much as potential height of the sward). Wire quadrats of 25 x 40 cm c/c made of 3 mm galvanised wire are re-usable and will last for several years.

(5) Emergence and establishment must be checked: samples may be taken using a core sampler from between the wire quadrats.

(6) Harvests to assess winter and spring production must be made to ground level. Record yields in kg DM per hectare.

(7) At maturity, take samples for assessing comparative seed production above ground and below ground using a large coring device (> 15 cm diameter). Samples for below-ground seed production should be taken to a depth of 2.5 - 3 cm or slightly more in pure sands.

(8) Germinate whole pods to check percentage of hard seed.

(9) Leave at least one set of quadrat sites to assess regeneration of the clover in the second year and the residual hard seed in the soil.

(10) Seed yield, percentage hard seed and percentage buried seed must be given high priority in assessing new cultivars as these features determine seed reserves hence persistence, sward density and winter yield of cultivars.

5. Experimental Procedures in Grazing Experiments

(1) Selection of sites should be on the basis of accessibility and uniformity of sites.

(2) Selection of animals is best done by stratifying into body weight classes and allocating at random to treatment to ensure that all treatments have a range of animal sizes. Uniformity of age, breed, conformation and general health of each animal must be ensured in any grazing experiment.

(3) Replication: Ideally there are three or four replications but the cost is too high. It is better to have two blocks with 6 treatments than four blocks with three treatments in most grazing experiments. In stocking rate experiments with sheep, two blocks with five stocking rates is satisfactory. Five dry sheep per paddock or 8-10 breeding ewes per paddock is enough but these should be carefully selected before entering the experiment. It is important to select experimental animals from a larger population and leave 30-40% good animals as spares to graze at a medium to high stocking rate around the main experiment.

(4) In continuously-grazed experiments (stocking rate, supplementary feeding of grazing animals, etc.) it is necessary to use the 'open' and 'closed' quadrat system for assessing pasture production. For each stratum the procedure is as follows:

At the beginning of the season or before the break of season, select a site at random (e.g. by throwing coloured dart or arrow) and select a matching 'paired' site nearby. The sites should both be representative of the pasture in the stratum. Cut an open quadrat sample from one of the paired sites and place a quadrat cage on the other site.

After 28 days repeat the procedure of selecting two new paired sites. Cut an open quadrat sample from one of these sites, cut the

"closed quadrat" = caged sample site and move the cage to the newly-selected site.

Successive open quadrat yields of dry matter will describe the trends in pasture availability (green and dry) through the year while pasture production is estimated by summing the successive differences between closed and open quadrat yields, i.e. (Closed Day 28 - Open Day 0) + (Closed Day 56 - Open Day 28) + etc. until the end of the growing season.

(5) Botanical composition may be determined by hand separation of representative open quadrat pasture samples. The quadrat cage samples are useful only for estimating (in association with previous open quadrat cuts) the cumulative yield of the pasture. Alternatively, or in addition, the Levy Point Quadrat may be used to advantage for estimating botanical composition (percentage overlapping cover) and giving a precise indication of percentage bare ground in grazing experiments.

(6) In any studies involving pastures based on annual legumes it is essential to check seed production, seed reserves and the general seed-seedling dynamics through the year.

(7) Animals should be weighed every two weeks to coincide as near as practicable with pasture harvests (every 4 weeks) so that body weight changes can be related to pasture availability, maturity, etc.

(8) Dye banding of wool to study wool growth in relation to pasture availability can be a useful adjunct to other data.

V. SUMMARY OF WORKSHOP PROGRAM - MAY 4, 1983 (Field Work)

1. Tillage and Sowing Implements at Mitra

The good and bad points of various implements were discussed with the workshop participants. Tillage and sowing implements at Mitra are inadequate for timely and rapid soil preparation and sowing. Implements like the Multitiller are heavy and ground is covered slowly but the final job is quite good. Tyned tillage implements that are trailed rather than tractor mounted, and with wheels for depth control and stability, are badly needed to prepare level seedbeds at Mitra (refer Section III 3 (5)).

While the Massey 16-row disc drill is a useful implement for sowing on prepared seedbeds, a good tyned drill with plenty of clearance to allow passage over stony outcrops is needed at Mitra. Although the Tye Pasture Pleaser and Tye Stubble Drill will be useful machines for some of the small experimental areas, these lack the robustness and clearance needed to pass over stony outcrops - a requirement for broadscale sowing at Mitra. The 10 inch (25 cm) row spacings on the Tye machines at Mitra are unsuitable for general sowings of winter cereals or pastures *interalia* because of weed competition but this wide spacing is acceptable for the oversowing of pastures to increase the legume component (e.g. as needed on the Eipo experiment).

2. The EIPO Grazing Experiment at Mitra

This stocking rate experiment, which has served a useful purpose to show that potential carrying capacity on improved pastures is higher than formerly accepted in the Mitra district, was discussed with Workshop participants who also assisted in taking some soil cores (0 to 5 cm depth) to enable assessment of total legume seed reserves and hard seed reserves.

The EIPO experiment now has serious deficiencies as seen in the spring of both 1982 and 1983. Some economic interpretations of the data have assumed that the biology of the system in the EIPO experiment is adequate or optimal and it is not. The potential advantages of pasture improvement are no longer demonstrable in the EIPO experiment because the original legume seeds mixture was far from ideal. Furthermore, the feeding of hay with consequent reduced grazing pressure has obscured potential treatment differences and confounded not only the sheep data but also the pasture yield and botanical composition data.

A further problem with the data is that insufficient samples have been taken to give a true picture of pasture yield and data on botanical composition from protected sites (quadrat cages) is misleading. However, despite these criticisms the experiment has served a useful purpose.

There is now a need to oversow the EIPO experiment with the Nungarin (or Northam), Daliak, Seaton Park and Trikkala cultivars of subterranean clover to improve the legume status. However, the gross differences in pasture availability and botanical composition of this experiment in the spring of 1983 - varying from tall pure grass at low stocking rates to very short legume-dominant swards at high stocking rates point to the advisability of abandoning the site or at least destocking to allow cropping and a complete renovation of the site before resowing to pasture.

In any event it is important to collect sufficient 0-5 cm soil cores in September and March to permit accurate assessment of the impact of stocking rate on the total seed and hard seed reserves of the various legume species. Also 0-5 cm and 5-10 cm soil samples and a few deeper samples are needed for checking on changes in soil fertility on the various treatments. The best legume stands on the EIPO experiment in April-May 1983 comprised volunteer annual *Trifolium* species including *T. resupinatum* and *T. glomeratum* at the highest stocking rates.

3. The Vale Formosa Stocking Rate Experiment

When seen in May 1983 this experiment was suffering from prolonged lack of water. Pastures were very short and seed production of legumes and grasses was likely to be very low. Although the experiment site varied in slope and aspect it did not have the same problems of grass dominance on the low stocking rates as is the case of the EIPO experiment at Mitra. The Vale Formosa stocking rate experiment as seen in May 1983 was in urgent need of oversowing with a mixture of Nungarin (or Northam), Daliak, Seaton Park and Trikkala cultivars of subterranean clover also some *Trifolium glomeratum* and *T. resupinatum* if available. This oversowing should be done in autumn before the opening rains.

VI. SUMMARY OF WORKSHOP PROGRAM - MAY 6, 1983

This session related to specific queries raised by participants and discussion of their various worries/problems. With the help of the 35 pages of information given to participants the activities of the week were re-capitulated.

Participants realised by the end of the week that they could all play an increasing role in useful data collection and the futility of growing pastures to merely look at because there is an urgent need in Portugal to measure potential yield of pastures and forage crops (kg DM/ha) along with protein levels and digestibility.

The species, fertilizer and management inputs to ensure yield of pastures and forage crops coupled with reasonable levels of utilization (70-80% for annual pastures) and the plant and animal components that dictate efficient conversion of pastures and forage crops to livestock products were stressed in the final session.

The need for integrated soil-plant-animal-socio-economic studies to maximise benefit:cost ratios in research programs is urgent in Portugal as too many people are trying to work in isolation. Much more coordination and cooperation is needed between research and extension workers within and between research groups in Portugal. Above all, there needs to be clear Government policies on the direction and funding of agricultural research so that priority can be given to research and development in the very-important pasture-livestock sector. There must be more dependence on home-grown pastures and forages and less dependence on imported feed grains.

There is an urgent need for the training of more pasture agronomists in Portugal to undertake work of national importance. For example, there is negligible data available on potential productivity of pastures and forage crops. This data is prerequisite for any worthwhile predictions on possible improvement in ruminant livestock production.

The Universities and Institutes must lead the way by starting this training at the Undergraduate level. For example, senior students can be usefully engaged in assessing pasture resources in Portugal. In this way the young graduates get interested in real research and development problems of Portugal.

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APPENDIX A

(Copied as received from University of Evora: workplan subsequently modified)

PROPOSED WORK PLAN FOR DR. EDWARD CARTER

AT THE UNIVERSITY OF ÉVORA

APRIL - MAY 1983

One Month

Problem:

It is increasingly recognized that the Alentejo will have to depend upon rain-fed agriculture and outside of the best soils ("barros" and "para-barros") more emphasis will need to be put on a cereal-legume rotation (in the Mediterranean brown soils) or on improving the native pasture or planting improved pasture (poorer soils, "xistos" and below the cork and "azinheira" trees, the "montado"). The University of Évora with its various University farms and the potential for inter disciplinary research (agronomy, animal science, and farm management) is ideally located and suited to initiate research and ultimately (after 5 to 10 years) extension in this area of improving pasture with low cost innovations. The input of senior researchers from similar climatic regions is critical to define priority research areas with a high probability of pay off, help avoid non-productive research, provide an intellectual stimmulus within the University and for other technicians in the region, and facilitate cooperation between disciplines and institutions.

Objectives:

1. Make specific suggestions for the implementation of various research programs related to forage of both the AID and the German assistance programs.
2. Evaluate critically the on-going work in these areas, help analyze the data, and suggest future directions.
3. Facilitate the integration of the UE research with the forage program in Elvas and the Direcção Regional of Évora.

Relations to the contract:

As noted previously this is a priority area for UE and in the contract. It will be Dr. Carter's second visit to Évora.

Specific Products:

1. Two seminars

2. Help in organization and implementation of a 2 day seminar on problems of pasture and forage production in the Alentejo to be held at the University of Évora.

3. Final report including research and extension suggestions.

Qualifications:

1. Senior researcher in forage agronomy from a Mediterranean climate without substantial irrigation.

2. Previous time at the University of Évora and some knowledge of the Alentejo.

Calendar: First week

Meet with researchers at the University of Évora, visit UE farms and other farms and experimental sites in the region. (see the enclosed details)

Second week

Visits to Elvas and Fonte Boa.

First seminar comparing Portuguese and Australian conditions and experience in pasture and forage production.

Third week

Continue farm and experiment station visits. Help in organization and implementation of two day seminar at Évora. His lecture on Research Priorities at the University of Évora in Dryland Pasture - Forage production.

Forth week

Final report. Visits possibly including farm visits with the PROCALFER program. Continued interaction with UE scientists and those in other institutions.

APPENDIX B

ITINERARY: AUSTRALIA - PORTUGAL - AUSTRALIA APRIL 15 - MAY 16, 1983

(Including Main Organizations and Persons Contacted)

April 15 Departed Adelaide Airport 10.00 a.m. for Melbourne and boarded flight QF005 for Frankfurt via Singapore, Bombay and Rome.

16 Frankfurt - Lisbon on flight LH200 arriving 15.30 hr. Met by Eng. Pedro Silveira and Eng. Mario de Carvalho of University of Evora. After collecting Dr. Scott Russell from London flight travelled to Evora and on to the University Inn at Herdade da Mitra arriving c. 8.00 p.m. - a 44 hour trip from home in Adelaide.

17 Examining pastures at Mitra. With Pedro Silveira to lunch, then visited Herdade Quinta das Atafonas in the afternoon to see pastures and forage crops.

18 With Pedro Silveira to Santarem and visited MACP Experiment Station "Soidos". Discussion on pasture improvement program with Eng. Manuel Alfaiate, Director of Agricultural Production in the Ribatejo e Oeste Region. Arrived at Curia c. 1700 hr and booked into Palace Hotel for the IV Annual Spring Meeting of the Portuguese Society of Pastures and Forages commencing at 1800 hr.

19 Attending the Meeting all day. Met INIAER and PROCALFER program staff.

20 Field visits to Aveiro and Figueira da Foz regions. Saw State Farm Videira do Norte near Mira then Sociedade Agricola da Quinta de Foja at Figueira da Foz (Francis Stilwell) to see cattle grazing on improved pastures. During lunch break saw rice processing enterprise; then saw the Beira Litoral Regional Directorate of Agriculture property Quinta da Capa Rota. Dinner at School of Agriculture, Coimbra.

21 Attending the Meeting at Curia. Presented paper *New Pasture Technology for Mediterranean Zones such as the Alentejo*. Departed for Vila Real with Eng. Nuno Moreira and booked in at Cabanelas Inn.

22 With Nuno Moreira to meet Rector (Prof. Doctor Fernando Nunes Ferreira Real) and Vice Rector (Prof. Doctor Joaquim Lima Pereira) of IUTAD (Instituto Universitario de Tras-os-Montes e Alto Douro). Inspecting pasture and forage crop research programs of Nuno Moreira and others in the Crop Science Department. Lunch with Nuno Moreira and Eng. Fernando Gusmao, Head of the Agricultural Production Service of the Regional Directorate of Agriculture of Tras-os-Montes, Mirandela. Visited Animal Pathology Laboratory (Dr. Jorge Rodrigues), Soils Laboratory (Eng. Joao Coutinho) then Departments of Genetics and Plant Breeding, Biology (Prof. Jose Pereira), Forestry (Eng. Francisco Castro Rego) and Animal Nutrition (Dr. Jose Potes, Eng. Arnaldo Dias da Silva, Eng. Armando Mascarenhas Ferreira,Lic. Jorge Azevedo *et al.*) at Quinta de Prados.

April 22 Contd.		Saw animal houses and feeding experiments with sheep and cattle. General discussion with Crop Science Department on research programs at Vila Real and in the Region.
	23	With Nuno Moreira, Fernando Martins and Pedro Silveira to Mirandela to meet Eng. Gusmao, Cardosa Costa, Head of Planning in the Regional Directorate of Agriculture at Mirandela, Maria Antonia Cruz, Jaime Maldonado Pires (PROCALFER) and others at Herdade do Valongo (Ministry of Agriculture Farm). Inspected pasture experiments and new broadscale sowings. also barn-feeding of sheep. Lunch at Macedo de Cavaleiros, then visited Izeda Region to see good subterranean clover pastures on the family property of Eng. Jose Luis Baltazar.
	24	With Pedro Silveira returned to Evora from Vila Real via Guarda and Castelo Branco.
	25	Preparing for Seminars/Workshop at Mitra.
	26	Discussion with Crop Science Department staff. Lunch with Rector, Professor Ario Lobo Azevedo. Discussion with Animal Science Department then at 1800 hr had discussions with Prof. Carlos Portas.
	27	With Pedro Silveira and Pedro Vacas Carvalho taking soil-core samples from EIPO experiment and other fields to measure legume seed reserves. With Pedro Silveira to Lisbon in the afternoon to meet Eng. Andre Dordio to finalise plans for the University of Evora and PROCALFER workshop and to collect unaccompanied baggage (books, pasture survey equipment, etc.).
	28	Meeting with Eng. Almeida Alves at 0830 hr at Mitra. Meeting with Prof. Mariano Feio, Head of Natural Science Department, to discuss comparative climates of Portugal and South Australia. Meeting with Goncalves Ferreira and Francisco Garcia and visited farm near Evora with good natural leguminous pastures. Met at 1430 hr with Dr. Herbert Albrecht (GTZ). Meeting with Prof. Antonio Pinheiro, Head of Economics Department. From 1800 to 2000 hr at Eugenio de Almeida Foundation for discussion with Dr. Granadeiro, General Manager of the Foundation.
	29	With Pedro Silveira, Jose Banza, Helena Estudante and Pedro Vacas de Carvalho to visit University of Evora farms Herdades Almocreva, Outeiro and Daroeira.
	30	With Pedro Silveira and Pedro Vacas de Carvalho to visit farms in Montemor-o-Novo region to see cropping and pasture-livestock enterprises.
May	1	Preparing for Evora/PROCALFER Pasture and Forage Crop Workshop.
	2	Preparing for Workshop in morning. At 1430 hr started the Workshop program at Mitra with discussion of methods of assessing yield and botanical composition for c. 60 participants. From 1630 to 1830 hr Workshop members practised using the Levy Point Quadrat for pasture survey, soil coring for sampling legume seed reserves, and harvesting herbage samples.

May 3 Laboratory practise by Workshop members in estimating botanical composition of mixed pasture samples and in hand-separation of pasture samples - from 0930 - 1100 hr. Continued Workshop program as shown on page 2 until 1800 hr.

4 From 0930 - 1230 hr examined and discussed tillage and sowing equipment at Mitra also the EIPO grazing experiment at Mitra including taking soil cores for measuring legume seed reserves. From 1330 to 2100 hr with Workshop participants to Vale Formoso to see stocking rate experiment and PROCALFER species and fertilizer experiments.

5 Detailed instruction and discussion of field experimental procedures for evaluation of pastures and forage crops including fertilizer experiments and grazing experiments from 0930 to 1300 hr and from 1430 to 1800 hr. Note: During discussion on fertilizer experiments Eugenio Sequeira of INIAER, OIERAS, showed slides of some of his research results from pot culture trials with micronutrients. Lunch with Dr. Gunther, Purdue University representative in Portugal.

6 From 0930 - 1300 hr a general discussion on soil-plant-animal research techniques related to pasture and forage crop production concluded the Workshop. From 1500-1900 hr visited farms of the Eugenio de Almeida Foundation.

7 Re-writing material presented at Workshop for Final Report.

8 Re-examined EIPO grazing experiment and continued re-writing material presented at Workshop for Final Report.

9 From 0830 - 1400 re-visiting pasture areas sown in 1982 PCAA (World Bank) program in Redondo Region - accompanied by Eng. Pedro Silveira, Eng. Pedro Vacas Carvalho and Eng. Louiza Correia. At 1430 with Prof. Santos Junior to see soil drainage experiment near Evora. At 1630 with Prof. Jose Dargent Albuquerque, Mario de Carvalho, Pedro Silveira, Pedro Vacas Carvalho, Jose Banza and Helena Estudante for discussion and inspection of tillage and sowing equipment. At 1800 hr visited local machinery manufacturer "Premetal" of Evora also saw John Shearer (South Australia) scarifier and drills at Posto dos Currais.

10 Final meeting and discussion with Animal Science Department Staff concerning their research proposals (0930-1145). With Pedro Silveira and Rector Azevedo for discussion and lunch with Dr. Conceicao, Commercial Adviser, Australian Embassy. Final meeting and discussion with Agronomy Department Staff also inspection of rotation experiment at Mitra from 1600 to 1930 hr.

11 Final discussions with members of Natural Science Department Staff regarding research proposals on the role of legumes and fertilizers on soil fertility. Met with Prof. Carlos Ferreira de Miranda and Maria Manuela Mota Batista of the Chemistry Department to discuss and inspect laboratory facilities and their specific research on molybdenum. Final meeting with Rector Azevedo at 1730 followed by farewell dinner with Agronomy and Animal Science Staff members at Mitra.

May 12 Departed Evora with Pedro Silveira for Pegoes for meeting with Eng. Chicau, Regional Director of Agriculture in Ribatejo-e-Oeste, Eng. Andre Dordio, Eng. M. Alfaiate and others. Saw and discussed several experiments and paddock sowings of pasture and forage crop species. Following lunch at Pegoes visited the largest State Farm in Portugal (Companhia das Lezirias) comprising 16,000 ha of sandy soils and 8,000 ha of river flats. Saw and discussed pasture trials and grazed dairy cow and sheep pastures with Prof. Nuno Potes, Francisco Freire, Joaquim Eduardo Correia and Luiz Roche. Checked in at Hotel Rex Lisbon then visited the Portuguese Society of Agronomic Sciences at 1830. Dinner with Prof. Carlos Portas, Prof. Janick (Purdue) and others.

13 Consigned unaccompanied baggage, then to Oieras to meet Dr. Black (PROCALFER) and Eugenio Sequeira and his colleagues in the INIAER Soils Department. Met Mr. Donald Finberg, Charles Buchanin and others in AID Mission for de-briefing session. Met Eng. Almeida Alves at 1830 for further discussion which continued with Pedro Silveira and Andre Dordio over dinner.

14 Departed 1000 hr from Hotel Rex to board TAP flight TP552 for Frankfurt connecting with QF006 departing 2130 hr for Melbourne via Rome, Bombay and Singapore.

15 Travelling to Australia.

16 Arrived Melbourne 0700 hr, then by domestic flight to Adelaide arriving home at 1200 hr.