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**PORTUGAL UNIVERSITY
INSTITUTES
DEVELOPMENT PROJECT**

(Contract AID/NE-C-1701)

**REPORT ON
SHORT-TERM STAFF ASSIGNMENT**

**Submitted by
DR. MICHAEL COLLINS
Department of Agronomy
University of Wisconsin**

February 21 through March 28, 1983

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PORTUGAL UNIVERSITY INSTITUTES DEVELOPMENT PROJECT

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REPORT ON
SHORT-TERM STAFF ASSIGNMENT
at the

Instituto Universitario de Tras-os-Montes e Alto Douro
Vila Real, Portugal

21 February - 28 March, 1983

Submitted by

Dr. MICHAEL COLLINS
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AREA OF ASSIGNMENT:

Forage management and quality.

SPECIFIC OBJECTIVES:

To support Eng. A. M. Ferreira in field and laboratory experiments concerning corn silage. To advise other staff members working on forage production and utilization.

PORTUGUESE COUNTERPARTS:

Eng. Armando Mascarenhas Ferreira

SUB-OBJECTIVES

Work conducted during this assignment had several sub-objectives within those stated under SPECIFIC OBJECTIVES. These can be outlined as follows: (1) to prepare dissertation data collected by A. M. Ferreira for statistical analysis and subsequent interpretation, (2) to establish the capability for plant tissue analysis for total sugars, starch and total nonstructural carbohydrates in Animal Science research laboratories at IUTAD, (3) to prepare and present a seminar based on forage research in the Department of Agronomy at the University of Wisconsin which relates to current or needed forage research at IUTAD, and (4) to review plans for studies to be initiated during 1983 and to advise regarding future research needs.

Sub-Objective 1:

Corn is widely used as a forage crop in northern Portugal, primarily under irrigation. Previously, no research had been conducted in the IUTAD area to evaluate corn forage yield and quality. The studies conducted during 1979, 1980, 1981 and 1982 will provide useful information on corn in this area. The variables evaluated include cultivar, plant population and harvest date (maturity stage). Samples of the whole plant were collected for analysis as well as separate samples of stem, leaf and ear. Detailed tissue analyses are being conducted on each sample including N (to estimate crude protein) in vitro organic matter disappearance (IVDMD), neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose, acid detergent lignin (ADL), minerals, total sugars (TS), starch and total nonstructural carbohydrate (TNC). Analysis is complete for 1979 samples and is nearly complete for all studies. Available data have been prepared for transfer to computer cards for statistical analysis.

The first step in statistical analysis of the data should be an analysis of variance with F tests for all treatment effects and interactions. Regression analysis should be conducted for quantitative treatments with graded levels such as plant population and sampling date. Single degree of freedom tests for linear, quadratic, cubic etc. components of regression will identify the equation which provides the best fit to the data.

Among environmental factors, temperature is one which exerts a large influence on physiological development of corn. A great deal

of research has been conducted in central and northern Europe in an effort to describe the relationship between corn growth and air temperature. A number of systems have been developed for quantifying the cumulative effects of temperature on plant development. In all cases, the variable of interest in corn development (such as maturity stage of the grain) is quantified and regressed on the accumulated heat units since emergence. Three systems for accumulating heat units will be used in analysis of data from these studies. In addition to being useful in research data interpretation, calculation of the long term mean number of heat units available in a particular location can aid in identifying the best cultivar for use in that area.

Sub-Objective 2:

One result of this assignment that relates to dissertation research by A. M. Ferreira and to other research at IUTAD is the development of the capability to analyse plant tissue for total and reducing sugars, starch and total nonstructural carbohydrates. These compounds serve primarily as storage and transport forms for carbon and energy in plants and thus are important in many studies of plant development and physiology. The nonstructural carbohydrates are also very readily digested by both ruminants and monogastrics and thus are important in forage quality evaluation. The pH reduction which is critical to silage preservation results from acids produced during fermentation of these same compounds.

The procedure being used combines enzymatic hydrolysis of non-structural carbohydrates (starch, sucrose, maltose, fructosan etc.)

to monosaccharide (reducing sugars). A copper reduction technique is used to measure reducing power in the sugar solution. By using 80% ethanol extraction and acid hydrolysis the reducing sugars, sucrose and starch can be measured separately. The reducing power rest is by titration, thus the equipment needs for the procedure are minimal. Samples from the 1979 and 1981 trials were analyzed at the University of Wisconsin. Samples from the 1980 and 1982 corn trials will be analyzed at IUTAD. I believe that researchers in Animal Science, Agronomy, Soil Science and possibly others will find this analysis useful.

Sub-Objective 3:

A seminar was presented describing forage research in the Department of Agronomy at the University of Wisconsin which relates to forage production and utilization problems in northern Portugal. Studies to evaluate K and S fertility effects on growth and atmospheric nitrogen fixation by red clover and birdsfoot trefoil were discussed. These legumes may have potential in some situations in northern Portugal. Both persist and grow under low to medium pH conditions and in soils with poor drainage. I believe that the use of legumes to provide protein for feeding ruminants may become more important in the future as concentrate feeds become more expensive and the cost of nitrogen fertilizers increases.

Studies designed to evaluate rain damage effects on forage yield and quality were described. Rain damage losses during hay curing

result from leaching, respiration by both microbial and plant enzymes, and leaf shatter. Severe rain damage may reduce yield drastically and also reduce feeding value by increasing NDF concentration and reducing digestibility and the concentration of several minerals.

The use of the round bale (large hay packages weighing 450-900 Kg) for hay harvesting was discussed. Research indicates that D. M. losses during baling of legume hay are higher for round balers than for the traditional rectangular baler. The total cost per unit of hay is generally lower, however, because labor costs are reduced. Grass hay, which is the most common type in northern Portugal, is less susceptible to leaf loss during baling than is legume hay. One means of reducing losses during baling is to bale the hay at a lower D.M. percentage. Our research indicates that considerable heating may occur in round baled hay with less than 81% D.M. Heating reduces forage digestibility, especially for the protein fraction, through a sugar:amino acid reaction which renders both indigestible.

Round bales can be stored outside if necessary and eliminate the need for inside storage space. Storage losses can be reduced by using crushed stone or poles to elevate the bales several centimeters above the soil surface.

Sub-Objective 4:

A field study will be initiated by A. M. Ferreira in spring 1983 to evaluate forage production using sorghums. Several plant types will be studied including sudangrass, forage sorghum, sorghum x sudangrass hybrid and sweet sorghum. Sudangrass has finer stems than

the other sorghums listed and greater tiller production. Forage sorghum and sweet sorghum are taller than sudangrass, have coarser stems and tiller less. These sorghum types will be compared with three corn cultivars (early, medium and late maturity) both with and without irrigation.

Sorghum is widely used as a silage crop in low precipitation areas of the United States. This crop requires less water for growth than corn and might be the superior crop when irrigation is not available. It is expected that corn will be the higher yielding crop when both are well supplied with water. In addition to yield measurement, another important objective of this experiment is to compare the nutritive value of each cultivar. This experiment should be conducted during two or more years in order to estimate the importance of seasonal variation.

Eng. L. Baltazar indicated an interest in evaluating cultural practices in sorghum production for forage. The use of minimum tillage techniques for seeding the sorghums would be compared with seeding in a prepared seed bed. I believe agronomic studies such as this, together with the nutritive values evaluation planned by A. M. Ferreira, will provide needed information regarding the potential usefulness of this crop.

Eng. Nuno Moreira has an ongoing research program designed to evaluate oat-vetch mixtures for winter forage production. Both of these crops are well adapted to this region and are currently in use for forage production. Samples from these studies are being tested for total nitrogen (to estimate crude protein) and in vitro organic

matter disappearance by Eng. Ferreira in Animal Science. Such cooperation between departments will take full advantage of the expertise of all personnel and should be encouraged.

In areas with no irrigation potential, in situ stockpiling of winter herbage production for summer utilization should be investigated. This technique has been utilized in California with bur clover (Medicago hispida) with success. Bur clover is a reseeding winter annual legume which grows during spring. The forage produced can be left in place to be gazed during summer when production is very low. Leaf loss and leaching by rain after the shoots desiccate are two sources of loss in such a system. The inputs are low, however, and might improve summer pasturage availability in some areas.

Silage produced from oat-vetch mixtures, whole plant corn, and other crops is often on effective and economical means of storing forage. Research involving an assessment silage quality should include measures of the end products of fermentation, primarily acetic acid, propionic acid, butyric acid, valeric acid and lactic acid. The concentrations and proportions of these various acids in the fermented material, along with pH and NH_3 levels, gives a good picture of the overall quality of the preservation. Lactic acid can be measured using colorimetric techniques. Measurement of the 2, 3, 4 and 5 - carbon volatile fatty acids requires the use of a gas chromatograph: This equipment is also used in the standard assay of nitrogen fixation capacity of legumes by measuring ethylene gas production. Thus two important research areas could potentially be addressed using this instrument.