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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
Madison, Wisconsin

June 24 - July 25, 1984

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AT THE

INSTITUTO UNIVERSITARIO DE TRAS-OS-MONTES E ALTO DOURO

VILA REAL, PORTUGAL

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PORTUGAL UNIVERSITY INSTITUTES DEVELOPMENT PROJECT

Report on Short-term Staff Assignment

AREA OF ASSIGNMENT

Forage management and quality

SPECIFIC OBJECTIVES

To support 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

RESEARCH WITH CORN FORAGE

The majority of time on this advising program was devoted to discussion and interpretation of data for the Ph.D. dissertation of Eng. A. M. Ferreira. Statistical analysis of the data was completed during September and October 1983, using computing facilities at the University of Wisconsin. Tables and figures were prepared and the results were evaluated in light of the scientific literature on corn forage from the U.S. and Europe. Four years of research, 1979-1982, have been completed studying cultivar, plant population, physiological maturity and plant component effects on yield per plant and on quality of corn forage.

French research with corn production in recent years has indicated that, under those environmental conditions, plant populations as high as 250,000 or more plants per hectare maximize dry matter yield and have little effect on forage quality. High populations reduce the production of grain; however, the carbohydrates which would otherwise be translocated to the ear remain in high concentrations in the stem tissue. Thus, the digestibility declines only slightly compared with well-eared corn. Very high populations will likely maximize yield per hectare for those cultivars sufficiently late in maturity to make full use of the available growing season. Results of these experiments suggest several additional areas of research that are needed to address practical questions in corn forage production in Northern Portugal. For example, knowledge of population effects on silage yield on a field scale would be useful. Because of the diverse environmental conditions that exist in Northern Portugal, data relating to forage yield and quality of corn at three or more locations representing different environments would be useful. A field experiment currently under way will provide data on ten corn cultivars harvested at three maturity stages.

RESEARCH WITH PERENNIAL FORAGES

I met with Eng. J. M. F. Abreu and A. M. Ferreira to discuss research funded by the World Bank. The overall objective of this project is to evaluate perennial forage crops for use in a rotation system with potato and small grains. The impetus for investigating rotation cropping systems comes, in part, from the increasing nematode problem on potatoes grown for several years on the same field.

The forage component would probably occupy the land for two or three years and could be used in feeding dairy or beef cattle.

Perennial and annual ryegrass, smooth bromegrass and red clover are being evaluated at two locations. Four grass-clover mixtures, two Italian ryegrass cultivars, four perennial ryegrass cultivars, four smooth bromegrass cultivars, and four red clover cultivars make up the treatments. Plots of pure grass receive 300 kg/ha of N annually applied in early spring and after each harvest. Pure stands of red clover are not fertilized with N and the mixtures get 150 kg/ha of N. Each plot consists of 12 rows 12.5 cm apart and 3.0 m long. One-half of the area is clipped every 28 days after the first harvest to simulate a pasture management system. The other half is cut every 42 days after the first harvest to provide information on a hay or silage management system. The central portion of each plot is harvested using a quadrat and the green weight is recorded. Approximately 800 g fresh weight of material is selected after thorough mixing for separation into grass, clover and weeds. Selected samples will be analyzed for crude protein and in vitro organic matter disappearance.

Samples are harvested by hand using a scythe. Larger plots, in the order of 2 m by 6-10 m, would be possible if a mechanical harvester could be purchased. The larger samples, possibly using a mechanical mower, would improve the estimate of hectare yields and would also increase the number of plots that could be handled with the labor available.

As part of the same project, a grazing experiment was discussed which will be initiated in 1985. The objective of this experiment

is to measure the response of yield, botanical composition and quality of native pastures to liming and to N, P and K application. Soil pH is below the optimum for plant production on most of the soils in this region and liming to increase pH can be expected to increase yield. Common practice by producers is to irrigate these pastures and to utilize the forage by either controlled grazing or by harvesting hay.

Two or three pastures will be selected on private farms in the region that are representative of this type of pasture. Each will be divided into six paddocks and three randomly selected paddocks will have lime added and fertilizer applied as recommended based on soil analysis. The other three paddocks will be left untreated as control pastures. Six quadrat samples will be clipped randomly from each paddock when the forage reaches an average height of 25 cm and just prior to initiation of grazing. After sampling, the pastures will be grazed using sufficient numbers of cattle to remove the forage to about 5 cm stubble within 3-4 days. The collection of animal data was discussed. The absence of fencing prevents individual data collection for each paddock. It is considered important, however, to utilize animals to remove the forage so that the effects of grazing on the pastures will be included. Yield and forage quality measurement for each pasture will allow assessment of the animal production potential of each system. After consideration, it was decided that all pastures at a given location should be harvested at the same time when the most advanced growth reached 25 cm. This might be expected to favor the fertilized pastures, since the unfertilized will likely be shorter than 25 cm at this time. Transportation costs, however,

and the time required for frequent observation of the pastures to identify the proper harvest stage are such that a single harvest date was decided upon. Such a harvest schedule will allow comparison of the response to liming and fertilization and this is the main objective of the study.

Once each season, during the three year study, the quadrat samples will be separated into individual grass, legume and other species for quantification and identification. This separation will allow evaluation of liming and fertilization effects on botanical composition of these pastures.

These experiments will provide information that will have immediate application to agriculture in this region. In addition, these studies are examples of the interaction between researchers at IUTAD and PROCALFER studies being conducted by personnel in the Agricultural Production Service, which should be encouraged.

LABORATORY PREDICTION OF FORAGE DIGESTIBILITY

Lau and Van Soest (1981) published research describing the use of a phosphate buffer extract and measurement of its optical density for estimation of digestibility of treated straw. In later work, Van Soest et al. (1984) found a correlation of 0.64 between the optical density of the buffer extract at 280 nm and in vitro organic matter digestibility of treated and untreated straws combined. An increase in OD_{280} following NH_3 or OH treatment is interpreted as an increase in the content of soluble phenolics in the solution. The reaction of lignin in straw cell walls with bases results in hydrolysis of some covalent bonds between lignin and hemicellulose

or cellulose and renders the latter constituents more digestible.

Following buffer extraction, the fiber residue is hydrolyzed by boiling in a NaOH solution. The amount of NaOH reacted per unit of fiber weight can be quantified and reflects the quantity of lignin that is susceptible to hydrolysis. In straws, the saponification value is often highly and negatively correlated with organic matter digestibility.

A study was initiated during this advising program to measure the correlations between buffer OD_{280}, saponification value and DM and cell wall disappearance in vitro of approximately 80 samples of cool season grasses and legumes and corn. If OD_{280} is found to be well correlated with forage digestibility, it could provide a rapid and inexpensive method for digestibility estimation. Within a group of 12 samples of smooth bromegrass harvested at four stages of maturity, the correlation between in vitro true digestibility and OD_{280} was $r = 0.96$. Orchardgrass and tall fescue harvested on the same dates had correlations of $r = 0.94$ and $r = 0.97$, respectively. Although this herbage has not yet been analyzed for protein, it is likely that the correlation between OD and digestibility is positive due to the relationship between protein and forage maturity, which is negative in these species.

The fiber residue that remains after buffer extraction will be treated with NaOH as described earlier and the saponifications value recorded. The relationship between this value, which reflects the amount and extent of bonding of lignin, and the extent and rate of cell wall disappearance in vitro will be evaluated.

GENERAL COMMENTS AND SUGGESTIONS

I have been positively impressed with both the quantity and the quality of the research being conducted in the forage area at IUTAD. Studies are being done that will contribute to answering questions that exist in this critical area and also provide some basic information to increase our knowledge of factors affecting forage quality. Although some equipment is still needed, laboratory facilities are available to conduct the analyses that are essential to assessment of forage nutritive value. Critical peer review of each proposal for new research will help to insure the scientific merits of the proposed work and that the methods to be used will allow testing of the hypotheses of interest.

The need for interaction and cooperation between IUTAD faculty and the personnel of the Regional Directorate of Agriculture-Agricultural Production Service is great. Information gained from the research being conducted by IUTAD researchers must be transferred to forage producers before it can be put to use in increasing the yield and/or efficiency of animal production in Portugal. The design and analysis of many of these experiments is complex and the results of these studies must be interpreted in relation to practical forage and animal production. Two modes of publication seem logical for these studies. Other scientists conducting related research can be made aware of these results by publication in refereed journals in the field. The results of these same studies should be prepared in a format intended for use by extension personnel in working with farmers. Often, the latter publications can be authored jointly by

the researcher(s) involved and an extension specialist in that expertise area.

This interaction can and should extend to the planning phase of the research. The several projects funded by the World Bank provide good examples of experiments directed by IUTAD staff with the cooperation and input of Agricultural Production Service personnel.

LITERATURE CITED

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