



**PORTUGAL UNIVERSITY
INSTITUTES
DEVELOPMENT PROJECT**

(Contract AID/NE-C-1701)

**REPORT ON
SHORT-TERM STAFF ASSIGNMENT**

Submitted by
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September 22 through November 3, 1983

Portugal University Institutes Development Project

(Contract AID/NE-C-1701)

Report on

Short-Term Staff Assignment
and
Research Methodology Seminar

at the

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

September 22 to November 3, 1983

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1. Area of Assignment

- a. To serve as resource persons in the areas of research methodology, analysis of experimental data and design of experiments.
- b. To acquire knowledge of agricultural methods in Portugal and to relate these to the research program.

2. Specific Objectives of Assignment

- a. To serve as resource persons in the areas of research methodology, analysis of experimental data and design of experiments through
 - (1) Presentation of 30 hours of lecture in a Seminar on Research Methodology given by Drs. Martin and Lechtenberg.
 - (2) Administration of a Purdue University course (ANSC 691, 1 credit) for graduate credit at IUTAD. Enrollment was open to persons who both participated in the Seminar and held the equivalent of a Baccalaureate Degree.
 - (3) Consultation with staff members at IUTAD on general and specific problems encountered in selecting research topics, designing experiments and analyzing data derived from ongoing research.
- b. Visit farms, research stations and personnel involved in research programs in order to acquire information regarding the status of Agricultural Research programs in Portugal.

3. Portuguese Counterparts

Significant discussions and contacts were established with the following persons:

- a. Engr. Jose Torres Pereira, Biology
- b. Dr. Jorge Colaco, Animal Genetics
- c. Engr. Arnaldo Silva, Animal Nutrition
- d. Engr. Nuno Moreira, Pastures and Forages
- e. Dr. Jose Potes, Animal Physiology
- f. Engr. Jorge Azevedo, Sheep Production
- g. Engr. Fernando Macedo, Mathematics
- h. Engr. Fernando Delgado, Technical School, Coimbra
- i. Engr. Antonio Mota, MACP, Mirandela
- j. Engr. Maria Mota, MACP, Mirandela
- k. Engr. Henrique Goedes Pinto, Plant Genetics
- l. Engr. Ester Portela, Soil Science
- m. Engr. Francisco Rego, Forestry
- n. Engr. Eduardo Rosa, Horticultural Crops
- o. Engr. Rui Loureiro, Technical School, Castelo Branco
- p. Engr. Valdemar Carnide, Plant Genetics
- q. Dr. Aura Colaco, Animal Physiology
- r. Engr. Carlos Abreu, Plant Protection
- s. Engr. Carlos Sequeira, Animal Nutrition
- t. Engr. Fernando Sereno, Physics
- u. Engr. Fernando Martins, Plant Science
- v. Engr. Jose Andrade, IFADAP, Vila Real
- w. Engr. Armando Mascarenhas, Animal Nutrition
- x. Engr. João Cortinha, Soil Science

4. Accomplishments with Respect to Objectives

a. An itinerary of activities is attached as Appendix III.

b. Seminar on Research Methodology.

(1) The thirty (30) hour course outlined in Appendix I was presented over a three-week period (October 6 through October 26). There were 71 persons who attended one or more lectures. Certificates of completion were issued to 41 persons on October 27. Lectures were given in English and were well received. Considerable discussion was generated in both the lecture sessions and consultation sessions. The degree of comprehension and understanding appeared to be high based on problems submitted for consultation.

(2) Twenty-six (26) persons indicated intent to register for graduate credit in Animal Science 691 and fifteen (15) completed the course. A list of those completing the course is in Appendix II. In addition to attendance, completion of the course for credit required consultation with either Dr. Lechtenberg or Dr. Martin concerning one or more problems of experimental design or data analysis. The degree of sophistication of experimental designs and data sets varied widely. These consultations were very informative with regard to the nature of and problems associated with Portuguese Agricultural research.

c. Consultation with staff members:

In consultation, 22 scientists were provided specific recommendations to resolve data analysis problems or improve experimental design. The problems ranged from cases of very simple analysis of variance or regression to situations involving confounding and unequal subclass numbers. Many of the research workers have knowledge of statistical methods and need to use that knowledge and gain confidence in their ability to use statistics in data interpretation. It appeared to us that the staff members gained considerable knowledge and confidence from the material included in the seminar. We were very pleased with the response to the seminar and the progress made by staff members in analyzing results of experiments.

d. Visits to farms and research stations.

Plant breeding, forage utilization, forage production, sheep production and other laboratories were visited on the IUTAD campus. One day was spent visiting the forage, livestock and crop rotation work at the Montalegre Station of the Ministry of Agriculture. Work of a group from the Institute of Cultural Affairs in villages was observed while visiting Mezio. On weekends and holidays, travel in the country, a visit with a grape producer and a tour of a winery provided some additional knowledge of Tras-os-Montes agriculture.

5. Problems Encountered and Observed

- a. The young members of the staff at IUTAD are enthusiastic, energetic and intelligent. In order to meet the training requirements of Portugal (Ph.D. in eight years), the research program of each will require knowledge of statistics. Limited help is available at IUTAD. Members of the staff have some basic skills in statistics, but lack confidence in their ability to use those skills. Further consulting effort and consulting through correspondence are desirable to help develop confidence.
- b. Library facilities need to be expanded to provide the information needed to support an expanded teaching and research program.
- c. Additional computer programs and staff training to promote usage of the computer are needed in order to simplify data analyses.
- d. Limitations in land and animal resources place limitations on the kind and scope of experimentation which can be conducted. Augmentation of the land and animal resources would allow more comprehensive experiments to be conducted.

6. Recommendations

- a. The AID project should provide some followup of this assignment by having one or more persons return to IUTAD to consult with IUTAD staff on experimental design and data analysis. Alternatively, or in addition to a followup visit, arrangements could be made for consulting by mail. IUTAD staff should be encouraged to contact Purdue consultants by mail with regard to questions concerning data analysis and experimental design. If problems and questions are well defined, this procedure could work satisfactorily.
- b. Develop consulting capability at IUTAD by providing the opportunity for a small number of IUTAD staff members to obtain training in statistics in the U.S. The necessary graduate training in methodology could be obtained as part of graduate training in an applied area such as plant science or animal science. The minimal level of training needed to function as a consultant would require commitment of at least one academic year to training in the U.S.
- c. Expand the available computer programs to provide more computer help in analyzing data at IUTAD.
- d. Provide additional land and animal facilities for IUTAD research programs.
- e. Expand the library facilities.

APPENDIX I

RESEARCH METHODOLOGY

Presented at

Instituto Universitario de Tras-os-Montes e Alto Douro

Vila Real, Portugal

October 6 through October 26, 1983

1. The Scientific Method:
 - a. Development of hypotheses
 - b. Testing hypotheses
 - c. Type I and Type II errors

2. Variability and Measures of Variance:
 - a. The normal distribution
 - b. Degrees of freedom
 - c. Distribution of means
 - d. Sample size and number of replications
 - e. Standard error of the mean and of differences between means
 - f. Additive and multiplicative coding of data

3. Considerations in Planning Experiments:
 - a. Definition of the problem
 - b. Identifying important factors
 - c. Selection of characters to be measured
 - d. Inference space
 - e. Replication and experimental error
 - f. Power of the experiment

4. Tests of Significance:
 - a. Chi-square
 - b. t-test
 - c. F-test
 - d. Statements of probability

5. Analysis of Variance, One-Way Classification:
 - a. Characteristics
 - b. Calculations
 - c. Random or fixed models
 - d. Subsamples
 - e. Pooling error terms
 - f. Variance components
 - g. Tests of significance
 - h. Tests of differences between pairs of means
 - i. Trend analysis

6. Analysis of Variance, Multi-Way Classification:

- a. Characteristics
- b. Interaction
- c. Effect of blocking
- d. Calculations
- e. Tests for comparison of paired means
- f. Graphic presentation of interaction
- g. Comparison of treatments when interaction is present
- h. Selection of proper error term
- i. Unequal numbers of observations in cells of the design including analysis when numbers are proportional
- j. Analysis of unequal subclass number data by method of equally weighted means

7. Regression Analysis with One Independent Variable:

- a. Functional relationships between dependent and independent variables
- b. Statistical relationship between variables
- c. Calculations
- d. Assumptions and limitations
- e. Variance due to regression, lack of fit and true error
- f. Tests of significance
- g. Variance of a predicted value

8. Correlation Analysis:

- a. Relationship with regression
- b. Calculations
- c. Tests of significance
- d. Intra-class correlation

9. Multiple Regression:

- a. The mathematical model
- b. Normal equations and calculations
- c. Interpretation of results
- d. Inference space
- e. Correlations among independent and dependent variables as a factor influencing the prediction equation

10. Curvilinear Regression

- a. Use in interpreting trends of treatment means
- b. Relationship to polynomial coefficients
- c. Fitting polynomial curves by multiple regression techniques
- d. Constructing the response curve or surface and locating points of optimal response
- e. Logarithmic, exponential, square root and reciprocal functions which are intrinsically linear
- f. Comparison of two intrinsically linear functions by using residuals

11. Analysis of Covariance:

- a. The mathematical model
- b. Assumptions
- c. Reduction of error mean squares
- d. Calculations
- e. Effects of covariance when the independent variable is affected by treatments

12. Estimation of Missing Plots:

- a. By covariance
- b. By minimizing error mean square

13. Design of Experiments:

- a. Factors considered in design
- b. Completely randomized design
- c. Randomized complete block design
- d. Complete block with factorial treatments
- e. Complete block when blocks are treatments
- f. Nested designs
- g. Split plot designs
- h. Split plots in time and space
- i. Latin Square
- j. Replicated Latin Squares
- k. Crossover designs
- l. Switchback designs

APPENDIX II

Persons Earning Credit for ANSC 691

1. Azevedo, Jorge Manuel Teixeira de
Rua Marechal T. Rebelo, 8
5000 Vila Real
Portugal
2. Carnide, Valdemar Pedrosa
B. Ave 1st Maio
5000 Vila Real
Portugal
3. Colaco, Jorge Antonio
P. Novo Portelinha, R/C Vilalva
5000 Vila Real
Portugal
4. Delgado, Fernando Jose
14-3 C St. Antonio Nobre
Coimbra
Portugal
5. Loureiro, Rui Casimiro
Rua S. João de Deus, 25-2nd ESQ
6000 Castelo Branco
Portugal
6. Macedo, Fernando Anibal Wolfgango Pereira de
Apt. 202
5000 Vila Real
Portugal
7. Moreira, Nuno Manuel Vasconcelos Taralos
Largo de Pioledo, Bl. D, 4 ESQ
5000 Vila Real
Portugal
8. Mota, Antonio Manuel Campea
B. Fomento, Bloco 10A
5370 Mirandela
Portugal
9. Mota, Maria de Graca Campea
B. Fomento, Bloco 10A
5370 Mirandela
Portugal
10. Pinto, Henrique de Pinho Guedes
Rua Cidade Espinho, 4th E.
5000 Vila Real
Portugal

11. Portela, Ester Maria Abranchescosta
141-5E Rua Teixeira Rebelo
5000 Vila Real
Portugal
12. Potes, Jose Alberto Caeiro
15-7ESQ, Misericordia
5000 Vila Real
Portugal
13. Rego, Francisco Castro
46 R/C Dto, Rua D. Afonso III
5000 Vila Real
Portugal
14. Rosa, Eduardo Augusto dos Santos
Quinta da Fonte, 1st F-E Timpeira
5000 Vila Real
Portugal
15. Silva, Arnaldo Alves Dias
Rua Marechal T. Rebelo, 153-8th E.
5000 Vila Real
Portugal

Appendix III

DAILY LOG OF ACTIVITIES

September 22. Traveled from West Lafayette to Lisbon.

September 23. Arrival in Lisbon was rather late and we were unable to schedule a visit at the AID Office. We visited with Jose Luis Pinheiro by telephone.

September 24. Traveled to Fatima, Batalha and Nazaré.

September 25. Traveled to Vila Real arriving at approximately 6:30 p.m.

September 26 and 27. Visited with and met several people involved with the Purdue project and began work on course materials. We prepared publicity material advertising the course and made arrangements for duplicating course materials.

September 28. We visited with Arnaldo Silva regarding research he is conducting on urea treatment of straw. The results of the studies looked good. The treated straw has a distinctive ammonia odor and is discolored much like straw treated with anhydrous ammonia. Silva adds water and treats the straw at 35% moisture under a plastic cover. We visited his research facilities and discussed some possible techniques he might use for reducing variation among animals in intake studies. Measurements of individual animal consumption on a controlled diet might be a useful concomitant variable.

September 29. Tom Gunter visited with us and discussed our consulting effort. He asked us specifically to visit with Silva, Moreira, Colaco, Azevedo and Macedo. The preparation of materials describing our course was completed and distributed to the faculty of IUTAD.

September 30. We continued working on course material and completed the first section of our lecture notes. We visited with Carlos Abreu and Francisco Rego regarding a pathogen-yield relationship in Triticale. Abreu had subjective scores of fungus infection, but good yield data. There was no replication of the experiment, but there were observations on six lines. The mean of each class of infection was based on 100 plants. A quick regression analysis showed a linear relationship ($r = -.97$). We advised Abreu that his information was certainly useful. Modifications in the experiment for future years could include field replication so that lack of fit and pure error could be more accurately measured. Quantification of the fungal classes should lead to a more accurate prediction of the relationship between yield and infection. We visited with Jose Potes regarding heritability of various milking traits and methodology of expressing progeny test data of dairy sires.

October 1 and 2. We traveled to Porto, spent Saturday night at Vila Do Conde and returned by way of Braga, Guimaraes and Mondim de Basto. Agricultural production in the coast region was observed.

October 3 and 4. We continued working on development of the course including preparation of visuals.

October 5. Holiday. Lechtenburg traveled to Lisbon and Mrs. Lechtenberg returned to the U.S. Martins visited a farm where grape harvest and production of Port wine was underway.

October 6. We started the course lectures following introduction by Reitor Real. There were 71 persons in attendance.

October 7. We continued course preparation and visited with Eduardo Rosa regarding analysis of data on the relationship between bulb seed size and yield of garlic. We suggested two approaches to analysis of variance and regression analysis to determine if interaction existed between bulblet position and bulblet size. We also visited with Arnaldo Silva regarding calculation of rate of digestion and estimation of time lag. An analysis of means was suggested since the relationship is known to be linear and the estimate of slope is accurately estimated from means.

October 8. We met with Andrade regarding problems of summarizing data and information from farm loan records of IFADAP. The caseload is approximately 3000 creditors. He needs additional information regarding progress of loans, summarization of money usage, etc. He was determined to sample the total caseload to obtain reliable estimates. We tried to discourage him from sampling, but rather to initiate a good information base. We felt that design of a reliable sampling technique would be extremely difficult, due to classification according to office, year and type of loan.

October 10. We continued working on course materials and consulted with Francisco Rego regarding his investigations of burn rate in forest litter. Considering the data available, a regression analysis seemed to be the only reasonable approach. It may be very difficult to predict burn rate from the available information. He probably needs some measure of moisture content of the forest litter which he does not have. We discussed alternative designs for studies of this nature.

October 11. Nuno Moreira raised questions regarding use of the "Z-table" following our reference to the Z-table in lecture on October 10. Fernando Delgado discussed his sheep data with us. He has a rather large set of data with several variables and is interested in studying variation in milk yield of ewes.

October 12. We visited again with Eduardo Rosa regarding analysis of his garlic experiment. He had completed the statistical analysis and wanted to discuss the interpretation. He had significant effects due to both size and position of bulblets. We pointed out that, in his case, the position was partially confounded with size. In order to clearly determine whether position had an effect it would be necessary to compare the regressions of yield on bulblet size for the inside and outside positions.

October 13. Nuno Moreira described his research projects and we helped him set up an analysis to estimate interaction. We suggested that he use a set of orthogonal contrasts for a six degree of freedom interaction and worked out the polynomial coefficients with him. We worked with Jorge Azevedo's student on Newman-Keuls test and on interpretation of interactions. We met and had dinner with Dr. Pestana from the University of Lisbon. Pestana teaches the second statistics course at Vila Real. We discussed the nature of statistical training in Portugal.

October 14. We visited with Azevedo regarding milk data from his goat study. The analysis of variance was straightforward. We also helped him set up a correlation analysis for carcass data. We consulted briefly with Eduardo Rosa regarding the analysis of variance of a second experiment he is conducting.

October 17. We helped Eduardo Rosa design a new variety evaluation experiment and a date of planting study. Silva and Azevedo visited with us regarding animal numbers in digestion trials. This was a follow up of our discussion the previous evening in class. Guedes Pinto had questions regarding contingency tables for Chi-square tests. After discussing his problem, we concluded that he had used an incorrect multiplier in calculating the Chi-square values. After making the correction, he reported that his Chi-square tests were much more reasonable. We worked with Macedo and Colaco on mathematical description of lactation curves using data on cows at IUTAD.

October 18. We traveled to Montalegre and visited the Ministry of Agriculture farm. We had a very interesting visit with Mr. Gusmão and an excellent tour of the farm and region. One activity concerns farming systems work in which a rotation of grass-clover (2 years) seed potatoes (1 year) and cereal (1 year) is being evaluated. The demonstration has been conducted over 20 years. We also observed work on irrigation and discussed work being conducted by IUTAD staff members. Cooperation between the two units seems to be quite good. Gusmão pointed out the nematode problem on seed potatoes is of great concern. Potato yields on the rotation systems have averaged twenty tons per hectare with yields sometimes as high as forty tons per hectare. Forage yields appear to be approximately ten tons per hectare in the second year. The stands of red clover looked very good. We traveled to a mountain pasture area near Montalegre. We also saw Barracão and Brown Swiss cattle maintained at the station.

October 19. We consulted again with Azevedo regarding growth rate data on lambs. He has weight data at different ages with more numerous data at young ages than at advanced ages. He had conducted regression analyses using several models. After studying his results, we recommended that he designate fifteen or twenty age classes and use all animals in each class to calculate a mean for each class and develop a growth curve based on means. This approach should allow calculation of a regression equation unbiased by large numbers of animals at young ages. We also discussed with Azevedo some of the questions he had regarding analysis of unequal subclass number data based on means. We worked with Delgado and Rui Loureiro on analysis of sheep lactation data. We suggested that they develop a "normal lactation curve" for first and second lactation data and adjust lactation data to a common length of time in order to remove effect of lactation length on milk yield. Adjusted milk yield can be analyzed by analysis of variance techniques. He has some confounding problems and should use deviations from flock means, if possible. Analysis should be within lactations (lactation 1, lactation 2, etc).

October 20. We visited with Nuno Moreira regarding analysis of a date of seeding experiment with oats. He was concerned with multi-year and multi-location analysis. We helped him set up the analysis with blocks nested in years and locations. Lechtenberg visited Guedes Pinto and his colleagues in plant breeding. They discussed possible ways to measure the relationship between seed size and number of abnormal segregations in each line.

October 21. Carlos Sequeira and a student visited with us regarding an analysis of lactation data from a dairy farm. There were no treatments or experimental tests involved. They were trying to quantify and describe characteristics of the herd and did not have a clear idea of the objectives of the analysis. Martin worked with Colaco and Macedo on problems concerning genetic simulation.

October 22. We traveled to Mezio and visited with representatives of the Institute of Cultural Affairs. We offered some suggestions on kinds of problems that might constitute researchable thesis problems and visited with them regarding their program and a development proposal that they have prepared for EEC.

October 24. We discussed Arnaldo Silva's urea-straw experiment with him. He had questions regarding appropriate mean separation tests and we suggested Newman-Keuls. He asked about orthogonal contrasts, but they did not seem to be appropriate in his case. We discussed several experiments with Antonio and Maria Mota. We helped them plan an olive tree experiment involving three varieties, two tillage methods and three population spacings. They had proposed a split plot design in which spacings would be the whole plot units. Such a design would have resulted in only three degrees of freedom for the whole plot error. Lechtenberg worked with them on an alternative design in which varieties would be the whole plot, tillage systems the sub-plots and spacings the sub-sub-plots.

October 25. Ester Portela and João Cortinha explained their missing plot problems to us. They had conducted a fertility study with levels of nitrogen and phosphorus as treatments. The experimental site contained a number of plots that failed to produce harvestable yield due to inherent traits of the soil at that site. After reviewing their data we suggested that they analyze the data as a completely random design with unequal numbers of observations. All of their treatments had at least two observations. Jose Potes visited with us and discussed the analysis of swine data that he has collected. He is interested in determining the effect of boars on litter size. The analysis appeared to be one that could be handled with an analysis of variance approach using unequal sub-class numbers. Fernando Sereno discussed his interest in electronics with us. He had no data to analyze but asked us to help him make contact with people at Purdue working in the processing of electrical signals and storing information electronically. We arranged for him to visit with Bill Friday.

October 26. Nuno Moreira visited with us regarding design of an experiment which will generate samples for laboratory analysis. The sampling would be destructive and could not be carried out on all plots. He proposed to measure yield on three replications and sample the fourth for laboratory analysis. Sampling time would constitute a factor in the experiment. We pointed out that the laboratory studies would not result in a good estimate of experimental error unless he was willing to assume the three way interaction equal to zero and suggested that he add two samplings to each sampling date from the other replications in the experiment. We also visited with Arnaldo Silva regarding calculations and analysis of a replicated Latin-Square experiment. We visited with Mascarenhas regarding analysis of a corn silage experiment. He had conducted the experiment at two locations with four blocks at one location and three at the second location. The experiment was a 3 x 4 factorial studying

population density and harvest dates. He expressed concern about the number of three-way interactions (location by population by date) that were significant and did not appear to be explainable or to be important biologically. After reviewing his analysis of variance tables and plotting some of the location interactions, it appeared that an appropriate analysis should consider locations to be random and the three-way interaction should be the estimate of error for testing treatments. His analysis looked very much like he had two components of error with the block by treatment interactions within locations behaving like a sub-sampling error.

October 27. We visited with Azevedo regarding his carcass evaluation correlations. He is trying to identify an easily measurable trait that could be useful in predicting carcass composition. He measured many variables (more than can be handled by IUTAD's computer in a single correlation matrix). We suggested that he select sub-sets of variables and identify those independent variables that have the highest correlation with the dependent variable. We again visited with Arnaldo Silva regarding analysis of his Latin Square study. We worked out the examples on a sheep nutrition study in which he had two 3 x 3 squares. Martin visited with Delgado regarding analysis of his sheep lactation data. Delgado inquired about the possibility of graduate study in the U.S. Fernando Martins visited with us regarding design of a potato experiment. We helped him with the design of a variety trial and a nematode-variety study. We suggested adding check treatments to the nematode study to document the change in nematode population independent of potato growth. We also discussed plot size for potato studies and suggested that he discuss this question with Dr. Erickson when he visits later in the year. Martin visited with Jose Potes and Rosa Canha regarding their analysis of the swine data. Closing ceremonies for the seminar were held with 15 certificates of credit and 26 certificates of completion being awarded. Reitor Real presided at this activity.

October 28. We worked with Eduardo Rosa concerning testing differences between regressions in his garlic bulblet size study. The regression analysis clearly indicated that only one regression line was present. This implies that the position of the bulblet had no effect on the growth of the garlic even though it appeared to be significant in the analysis of variance procedures. This discrepancy arose because of confounding between position effect and bulblet size.

October 31. Mascarenhas again visited us regarding his corn silage data. We continued to discuss the proper model and evaluate the two different approaches for making tests of significance in his data. We recommended that he include a section in his report dealing with this topic and that he consider locations to be random and make tests of significance using the three-way interaction. This will result in fairly conservative tests. Martin continued discussing modeling work on animal genetics and inheritance with Jorge Cqlaco and Macedo. We discussed results of the nitrogen and phosphorus study with Portela and Cortinha. The completely random design analysis had worked nicely. In fact, their experimental errors, assuming no blocking, were of the same order of magnitude as in previous years when they had analyzed randomized complete block experiments. Cortinha had worked out the contrast coefficients for orthogonal regression. We also discussed multi-year analyses. The study was conducted with one set of levels the first two years and were changed for the last two years. We suggested that they conduct two 2-year analyses. We worked through the analysis of variance model with them.

November 1. (Holiday) We left with Jorge Azevedo for Lisbon by way of the Serra da Estrela. We had a very enjoyable and pleasant trip and spent the night in Manteigas.

November 2. We left early for Lisbon and arrived about 3:30 PM. We visited Jose Luis Pinheiro at the AID office in the U.S. Embassy.

November 3. Traveled from Lisbon to West Lafayette.