ROLE OF STATISTICS IN THE EDUCATION OF AGRICULTURAL SCIENCE STUDENTS

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This paper deals mainly with the experiences of teaching statistics at the Agricultural Faculty in Novi Sad. Statistics was incorporated into the teaching programmes for students from the establishment of the Agricultural Faculty in 1954. Statistical programmes are oriented to different agricultural courses at the Faculty. Statistical education for agriculturists tries to give them a solid foundation in statistics. An emphasis is placed on mastering a wide use of statistical methods in order to allow the students to apply these techniques in many fields of agricultural science like: field crops production, vegetable crop production, horticulture, fruit growing, grape production, plant protection, livestock, veterinary medicine, agricultural mechanization, water resources, agricultural economics etc. Problems and dilemmas encountered in statistical education will be presented and some ideas on how to improve the teaching of agricultural statistics. It is expected that the statistical knowledge achieved by finished agricultural students will provide a solid foundation for master degree studies in Biometrics. It is necessary to emphasize the important role of teaching statistics to agricultural students for improving their general knowledge and for better use of statistical methods in research work.

1.INTRODUCTION

The agricultural investigations are based on the application of statistical methods and procedures which are helpful in testing hypotheses using observed data, in making estimations of parameters and in predictions. The application of statistical principles and methods is necessary for effective practice in resolving the different problems that arise in the many branches of agricultural activity. Because of the variability inherent in biological and agricultural data, knowledge of statistics is necessary for their understanding and interpretation. Numerous activities in agriculture are very different from each other, resulting in different branches of agricultural science like: field crop production, vegetable production, horticulture, fruit growing, grape production, plant protection, livestock, veterinary medicine, agricultural mechanization, water resources, agricultural economics etc.

The importance of statistical science in agriculture is obvious, where the collection, analysis and interpretation of numerical data are concerned. Statistical principles apply in all areas of experimental work and they have a very important role in agricultural experiments. Statistics plays an important role in experimentation (Box, Hunter, & Hunter, 1978), while many scientific problems could be solved by different statistical procedures (Cobanovic et al., 1997).

This paper discusses the problems and successes connected with teaching statistics in agriculture. The necessity for the use of statistics in the education of agricultural students is of general interest. This interest was pointed out at the Agricultural Faculty of Novi Sad, where statistics has been included in teaching programs from 1954. The elaboration of statistical education and training at the Faculty of Agriculture in Novi Sad has been covered in one previous study (Hadzivukovic, 1991).

2. STATISTICS AND THE NATURE OF DATA

Modern agricultural production is characterized by some particularities and many different activities. So, it arises different problems and different nature of agricultural materials data which require different approaches to the use of statistical methods. Statistics is a discipline which mainly deals with data quantifications. Even in the case of nonnumerical data, statistical methods use transformations to change nonnumerical data to numerical data, with the aim of achieving some level of quantification to make conclusions about the matter of interest. Many data in agriculture are of numerical character which are accompanied with the existence of the variability of data. Variability is a characteristic of biological and agricultural data. Statistics can be used as a tool for research, spreading in many fields of research, like in agronomy. For these

reasons "statistics can, however, help the research worker to design his experiments and to evaluate objectively the resulting numerical data" (Steel & Torrie,1960).

Scientists use statistics as a tool, which, when correctly applied, is of enormous assistance in the study of the laws of science (Bethea, Duran, & Boullion,1985). It is important to emphasize that there are no statistical procedures which are applicable only to specific fields of study. There are general statistical procedures which are applicable to any branch of knowledge in which observations are made (Bethea, Duran, & Boullion, 1985).

There are many problems at the Agricultural Faculty of Novi Sad that have been elaborated through student's seminar and final works, under the guidance of mentors and using statistical methods. Some of examples of the use of statistics are related to: crop farming (wheat, maize, sugar beet, sunflower, soy, fodder crops, other industrial crops etc), vegetable crops (potatoes, tomatoes, beans, peas, onions, peppers etc), fruit growing (apples, pears, plums, cherries, sour cherries, apricots, peaches, walnuts etc), viticulture (grapes), horticulture plants, perennials, livestock breeding (cattle breeding, pig breeding, sheep breeding, poultry breeding), exploitation of agricultural machines and transport means, utilization and protection of waters, consumption of mineral fertilizers, consumption of plant protection preparations etc. Problems related to agricultural economics are: agricultural population, cultivable area, agricultural enterprises and cooperatives, individual (private) holdings, workers in agricultural enterprises and cooperatives, costs, sources of income etc.

Some examples of the application of statistical methods in problems through research processes at the Agricultural Faculty of Novi Sad are: genetics and plant breeding, crop production concerning different conditions of agrotechnics and plant protection, type of soils, localities, varieties, sorts, hybrids, conditions of irrigation, use of herbicides, plant physiology, plant biochemistry, genetics and livestock breeding, animal physiology, livestock production concerning different races, different conditions of animal nutrition, protection ,etc. Some other examples of the use of statistics are related to: the method of production functions in wheat, maize and sugar beet production, etc, the influence of particular factors on agricultural production, measuring of contribution of production factors and technical progress to the growth of national product, tendencies of production lines in agriculture, etc.

3. ORGANIZATION OF STATISTICAL EDUCATION

"Every practical statistical analysis is directed toward establishing a probability model of an appropriate level of complexity, which can then be used to make "predictions" in some sense, on the basis of which decisions can be made" (McLean, 1999).

The statistical education of agriculture students is very important for many reasons. The study of statistics is helpful in experimental work both for the analysis of the data and for the design of the experiment in such a way that valid and efficient results are produced. It is obvious that statistical methods are useful for students who are preparing themselves for specialisation in their field. Statistical methods used in agricultural science are useful also for better understanding and explanation of causal relations between existing phenomena.

A course of statistics for students in the biology groups: field and vegetable crops, fruit growing, grape production, horticulture, plant protection, livestock and veterinary medicine covers one semester. The teaching programme consists of the following main topics: Descriptive statistics, Theoretical distributions, Sampling, Estimation and hypothesis testing, Analysis of variance, Single classification analysis of variance, Randomized blocks design, Comparisons among treatment means, Linear regression and correlation, Time series analysis – Linear trend, Seasonal variations and Index numbers. In this course of statistics the accent is on the principles of planning of experiments, analysis of variance, and related tests.

There are two courses of statistics for agricultural economics students. The first course is similar to the statistics course for biology students, with addition of topics in demography. In this course of statistics the emphasis is on regression and correlation analysis and sample survey. The second course for students of agricultural economics provides the following topics: Sample survey – Sample plans: like stratified, systematic sample, Multiple and curve regression, Multiple correlation, Partial correlation, Time series analysis and Elements of decision theory. In this course the emphasis is on multiple and curve regression and correlation and sample plans. There

is one course for students of agricultural mechanization and water resources which is accentuated with topics related to: Theoretical distributions, Random variables, Distribution functions and expectation, Sample survey, Linear regression and correlation, Nonparametric tests and Nonparametric correlation.

Computing facilities are not sufficiently incorporated in teaching statistics. The main problem is lack of funding. Concerning the improvement of understanding of statistical concepts in teaching statistics it is concluded that computers have proved useful in facilitating any form of statistical analysis, but the easy access to computational facilities could lead to inappropriate analysis (Phillips, Jones, 1991). For many students, there is the problem of learning statistics. At the beginning of lessons, students face new terms and a special way of reasoning. Many students' problems in studying of statistics arise from insufficient knowledge of statistical terminology and from the fact that students' scholastic backgrounds are poor and heterogeneous. Exercises are provided with the real examples from the subject of study in order to gain familiarity with statistical techniques.

The aim of statistical education for the students at the Agricultural Faculty of Novi Sad is oriented to obtaining an understanding of statistical concepts and principles and to make efficient applications of statistical techniques to various data in agriculture. Statistical education prepares agricultural students to attend the course of Biometrics on master degree studies.

Some dilemmas are focused to the question is it opportune that some of methods of multivariate analysis should be included in existing teaching programmes for biology groups. The inclusion of some of these methods would improve the possibilities of investigation, but the main problem is limited fund of study lessons. Some of other dilemmas relate to the question is the statistics learned sufficiently. As statistics belongs to methodological disciplines, agricultural students use it in such a way that is enough to help them in solving the problems and to improve their explanations. They are not ambitious to use "more statistics" than it is necessary.

According to our experience, agricultural students at Novi Sad University level are getting well educated in applied statistics, which is useful for their further specialization and research work. Finished agricultural students have achieved a satisfactory knowledge of statistics which is helpful in their research and scientific work: in defining the problem of investigation, in data analysis, in planning of experiments, interpretation of results, etc.

In our opinion students from some other faculties of Novi Sad University do not have enough statistical education. For example, medical science students or biology students have very few teaching programmes in statistics, which we consider to be a shortcoming. For example, basic teaching programmes for medicine students include only descriptive statistics, probabilities, regression and correlation and elements of demography. If these students had more statistical education they would widely use appropriate statistical procedures.Better statistical knowledge would allow medical students to read and appraise the research literature most of which now includes statistical results

4. CONCLUSION

This paper relates to experiences in teaching statistics to agricultural students at the Faculty of Agriculture in Novi Sad. It has described briefly the content of the courses in statistics. Statistical education and training of agricultural students is designed for different study groups. It has emphasized the importance of the use of statistical methods which could be applied in research work. There are given some examples of the application of statistics in different fields of agriculture. It is possible to conclude that agricultural students reach a satisfactory level of statistical education.

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