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ECONOMIC ASSESSMENT AND ANALYSIS OF AGRICULTURAL EDUCATION PROGRAMS IN THE NORTH CENTRAL REGION

Iowa State University PH.D. 1980

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Economic assessment and analysis of

agricultural education programs

in the north central region

by

Larry D. Trede

A Dissertation Submitted to the

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CHAPTER I. INTRODUCTION

Background and Setting

Agricultural education in the land grant university is an integral part of the total educational process of the university. As a curriculum, agricultural education focuses on the preparation of students to enter academic and agribusiness occupations. Agricultural education as a discipline also has the responsibility to contribute to the total body of agricultural research and provide future educational opportunities for its graduates.

Pressures of tight budgets, limited staffing, and taxpayer resistance have forced administrators of agricultural education programs to examine their programs more closely in order to maintain quality. In the past, quantity and quality could largely be improved by adding more inputs, primarily funding for staff and operating expense. However, emphasis is now turning towards improving the quality of education with given resources, thereby improving the efficiency of the resources used in the educational process.

Agricultural education, particularly vocational education in the secondary schools, was formalized by the passage of the Smith-Hughes Act of 1917. This piece of legislation empowered the local school district with the responsibility of providing vocational education with the purpose of training students for the "world of work" upon graduation. Several years earlier, in 1862, the Morrill Act was enacted that provided federal lands in each state which could be used to establish at least one college whose curriculum would include the technical classical studies but still would emphasize subjects related to the nation's agricultural and industrial development. Thus, the birth of vocational education closely paralleled the land grant system. As the two programs matured and developed, the land grant system assumed the teacher education role -- educating, training, and often certifying teachers of vocational agricultural education.

Little or no attempt has been made to assess the resource use in agricultural education, particularly at the land grant university, and to determine its productivity and usefulness. Such an evaluation would prove extremely useful to administrators of these programs, policymakers in education, and many others, because the need for efficient use of resources is clear.

Economic analysis can be applied to agricultural education at land grant colleges and universities to determine its productivity and uses. Such an analysis encompasses the allocation of scarce resources to satisfy wants as fully as possible; however, economic analyses of agricultural education require adequate information on educational objectives, performance of various educational methods or inputs to achieve these objectives, and costs associated with these educational methods or inputs.

Economic analyses of educational programs focus on both macroeconomic and microeconomic problems. Macroeconomic problems in agricultural education deal with the broad economic questions encompassing the economic value of education, financing education, economic payoff of agricultural education, and public policy questions. On the other hand, microeconomic questions are concerned with the efficient operation of an educational system within a school district, college, or university. It deals with resource use, productivity, and costs.

Statement of Problem

Agricultural education as a discipline within the land grant system has objectives related to the three major functions of the university -- teaching, research, and service. The primary objective of the undergraduate teaching program is to develop within the undergraduate student the competencies necessary to become a successful teacher of agriculture in secondary or post-secondary schools or the professional competencies needed to enter an agribusiness occupation. At the same time, the graduate teaching program is designed to meet the educational needs of the graduate student pursuing an advanced degree in agricultural education. Agricultural education also contributes to the total body of agricultural research through a balanced program that contributes to the basic and applied body of research. The in-service and/or extension component provides opportunities for teachers and/or others to update themselves on changes in the field of agricultural education.

The purpose of this study is to assess, using economic criteria, the agricultural education programs in the land grant universities found in the north central region of the United States. Data from the departments within the region are analyzed to determine resources used, inputs/outputs, and efficiency of individual programs, and programs by size groupings. An economic model, using a production function, will be developed to assess the input/output relationships in the undergraduate teaching program and also to assess the supply and demand of vocational agricultural teachers. A secondary purpose of the study is to gather data on resources used in research and in-service programs.

The specific objectives of the study are to:

(1) Assess the current resource use for each of the major functions found in each department of agricultural education.

(2) Quantify the resources used and the output forthcoming from the use of these resources by size groupings.

(3) Develop and test a function which utilizes the data collected.

(4) Highlight significant components within each function of the program that can contribute greatly to the overall efficiency of that program.

Significance of the Problem

Program evaluation is important to any phase of public education. Program evaluation is helpful to the person or persons responsible for allocating resources within a program. With rising costs, tighter budgets, and inflation, administrators of such programs are going to have to be increasingly aware of the problems of resource allocation. Such a study of resource use in agricultural education at the land grant level would be helpful to department heads, agricultural education administrators in the college of agriculture and/or education, administrators of extension programs, and persons in local, state, and federal governments responsible for allocating tax funds.

Agricultural education in land grant universities in its early years placed emphasis upon the training and preparation of undergraduates for teaching vocational agriculture in the secondary and post-secondary level. Basic and applied research in agricultural education was very limited at that time. It has only been in the past several years that agricultural education as a discipline has broadened its horizons into more in-depth research and service. Therefore, a study assessing the current resource in use in agricultural education can more clearly identify the importance of the research and service function. Such a study can compare more meaningfully in economic terms the relationship between teaching, research, and service functions.

Limitations of the Study

This study will limit itself to the states found in the north central region of the United States. This in itself is a limitation to the study. However, a high percentage of the graduates entering vocational agriculture teaching are graduates from these land grant universities.

This study used a selected sample of agricultural education departments in the United States instead of a random sample; hence, few statistical inferences can be made about the total population of agricultural education departments. However, by using a selected sample, the data collected would be more reliable and accurate.

The sample size of 12 departments is itself a limitation; hence, it is nearly impossible to associate any reasonable probabilities to the measurable characteristics. However, the sample is indicative of current resource allocation by departments, since each department has essentially the same mission.

A single period study is also a limitation, because it shows resource use only in one year and does not reveal a shift in program emphasis and resources over time. Additional time series data would make the data more reliable.

There are a number of overhead costs that add to the costs of agricultural education programs. Examples are fixed costs associated with classrooms, laboratories, and buildings, as well as variable costs to operate and maintain these operations. These costs in addition to the costs related to support services to the faculty are not measured in this study. This does not make the study totally incomplete or invalid, since the direct costs associated with each major function are still identified.

Parts of the questionnaire required "judgment answers" rather than "factual data" answers on behalf of the administrator. The possibility of bias exists when providing such answers.

CHAPTER II. REVIEW OF LITERATURE

This chapter examines past research dealing with the evaluation of educational systems. It is divided into several parts -- educational inputs/outputs programs and their measurement, standards for measuring and evaluating teacher education, and production function research as related to education. Most research conducted during the last ten years in this area has been in secondary and post-secondary schools. Little or no research has been done in evaluating agricultural education programs in land grant colleges and universities. Thus, most research cited will focus on secondary and post-secondary programs.

Research in educational systems reveals that numerous variables conceivably affect both the performance and costs of educational systems. Since controlled experiments to establish the interrelationships between educational inputs and outputs are very expensive, most research projects have been designed using surveys to examine these relationships. These surveys have focused on economic input data, demographic data for students and teachers, student background data, and educational materials that affect and influence educational output.

Educational Inputs/Outputs and Their Measurement

Although economists have long been concerned with inputs, outputs, and their measurement, only recently have they tried to examine and measure the output of an educational system. The many intangible dimensions of education make it extremely difficult to measure the output, because there is not a system of weighting these outputs into a single measure. Lacking a single measure of output, researchers have frequently used inputs such as expenditures per student, teacher/pupil ratios, etc., to measure educational output. Readily observable physical inputs were first used to approximate educational quality. An example was used by Hirsch (7), who quantified certain inputs which were assumed to indirectly measure educational output. He used school districts which were ranked according to each input, and ranks were summed by school districts on all factors to form a composite rank. His index of educational inputs consisted mainly of factors used in educating students.

Dollar inputs are frequently used to measure educational quality. Zimmer (19), in a study examining school districts, used current operating expenditures per student and average daily attendance to measure educational quality. He attempted to show that instructional costs were closely correlated with educational output.

Standardized achievement tests are most frequently used as a measure of educational output. These tests avoid some of the limitations inherent in using educational inputs as a measure of output. However, it is frequently argued that these tests have a shortcoming in that they favor middle-class students. Project TALENT (5) collected data on four million high school students in a representative sample of U.S. high schools. Data were obtained on student achievement scores as well as outcomes such as college attendance, dropout, absentee, and delinquency rates. The Equal Educational Opportunity Survey, as presented by the Coleman Report (2), examined data from 5,000 high schools on student achievement and its relationship to the school. Both of these studies obtained measures of the student's socio-economic background, which was held constant so that realistic comparisons of schools operating under different conditions could be made.

Standards for Quality Vocational Programs in Agricultural/Agribusiness Education

In more recent years, agricultural vocational education has undergone significant changes to make its program more flexible to industry and educational needs. A long-range plan was developed to meet these desired changes. Three major areas have been identified -- identification and validation of occupations required in education in agriculture, identification and validation of competencies needed by students entering these occupations, and program standards in agricultural education.

The third phase of this long-range plan was a culmination of several years' efforts to develop program standards. A preliminary draft of these standards was developed during a three-day seminar in Kansas City, Missouri.

After this seminar, the Agricultural Education Department at Iowa State University was awarded an EPDA grant to validate the new standards and to develop dissemination and implementation plans. The results of the validation process were evaluated and summarized by the project staff, and a major report was issued (4).

The quality standards for vocational programs in agricultural education have been developed to serve as a model against which all existing programs and activities can be evaluated. The standards are also intended to serve as a guide for new or expanding programs.

Standards were developed for 11 general categories including secondary and post-secondary programs, adult education programs, teacher education in land grant colleges, and administrative and supervision standards. The teacher education standards contain input/output ratios useful as "bench mark" data for this study. Programs can be evaluated on the basis of whether they exceed, meet, or do not meet the standard.

Standards for the teacher education area dealt with several different phases of the program -- student recruitment, enrollment, advising, instructional program, graduate programs, in-service education, teacher certification, teacher placement, staffing, research, professional development and leadership, financing, facilities and equipment, administrative organization, and evaluation. Within each area, qualitative and quantitative standards have been developed. The quantitative standard for some of the major areas will be highlighted in the next few paragraphs.

Undergraduate advising

For undergraduate advising, the following standards are suggested:

(1) At least 10% of each full-time equivalent faculty member's load be allocated to undergraduate advising.

(2) The maximum number of advisees per faculty member is 25.

Undergraduate teaching

For teacher education programs, it is suggested that 75% of those students completing the agricultural education program with a secondary or post-secondary teaching objective be employed as vocational agriculture teachers.

Professional staffing

Several standards exist in regards to professional staffing in a teacher education program. Some of these include:

(1) Seventy-five percent of the agricultural education faculty have an earned doctorate degree, and 100% have earned master's degrees.

(2) All members of the agricultural education faculty have 12-month appointments.

(3) The minimum of four full-time equivalent faculty are employed to meet the technical education requirements of students in the following four areas: agricultural engineering and mechanics, plant and soil science, animal science, agricultural economics and business management.

(4) A minimum of two full-time equivalent faculty are employed to help students learn needed competencies in agricultural education, to advise students, and to supervise intern experiences.

(5) One full-time faculty equivalent is provided for each ten degree/certification recipients (M.S., Ph.D.). An equal number of full-time equivalent faculty provides research and/or in-service functions.

Research

In the area of research, the standards suggest a minimum of 10% of total staff time be allocated to research activities.

Educational Production Function

The production function, as an economic tool, can be used to analyze efficiency problems in education. The production function expresses a physical relationship between inputs and outputs. Production functions have been used largely to explain physical and biological relationships. Researchers in the physical and biological sciences of land grant colleges and universities have long conducted research providing information on the nature of the production function related to agriculture.

Production function research

Early attempts to estimate production functions were made by economists using technical production in agriculture. Justus von Liebig's "law of minimum," as cited in Heady and Dillon (6), was the first attempt to define the fundamental relationship between fertilizer or nutrients and crop yields. He believed that crop yields were proportional to the amount of nutrients supplied to or provided from the soil, and that when all soil nutrients are present in sufficient supply, addition of one or more would not increase yield.

Bondorff, as cited in Heady and Dillon (6), interpreted Liebig's law by the following algebraic form:

$$y = ax$$

where

y = yield response

x = quantity of nutrient

a = constant or coefficient defining the transformation ratio.

Soil scientists, in cooperation with economists, were largely responsible for the early development of production function concepts. It has only been in the last 40 years that attempts have been made to estimate livestock production functions. An early study in livestock production function was conducted by Jensen in 1942 (9). This study dealt with input-output relationships in milk production, using the algebraic form developed for a single input category. Numerous studies have been conducted on the form and quantitatively analyzing production functions in agriculture. These studies have been summarized by Heady and Dillon (6).

Since that time, agricultural production function estimates both at the farm and industry level have been widely used. Numerous studies have been conducted. Perhaps the most noteworthy to mention for industry application is the work of Cobb and Douglas. They applied a function for American manufacturing industries over the period 1899-1922. This was the first formal attempt to fit an emperical production function fitted to time series data. The function fitted was of the form

$$P = bL^{K}C^{1-K}$$

where

P = index of manufacturing output

L = index of employment

C = index of fixed capital

K = coefficient of production.

Production functions in education

Attempts to incorporate the production function concept into social sciences have been extremely limited. Several possible reasons exist to explain this phenomena. First, quantitative research in social sciences is relatively new and vastly unexplored. Second, data gathering methods and procedures have been somewhat limited. It has only been in the last few years that more sophisticated methodologies utilizing computer technologies have been developed and utilized by social sciences in education.

An educational production function can describe a multitude of choices open to an administrator of an educational program. It shows the output that various levels and combinations of inputs will produce for a given state of technology and environmental conditions. Knowledge of these production possibilities allows many economic principles to be applied.

Several studies have been conducted measuring input-output responses from secondary school situations. Many of these studies used simple multiple regression analysis to determine the effect of varying amounts of input on educational output. None of these studies attempted to use other forms of production functions to measure educational output. A brief summary of some of these studies follows.

One of the early studies was conducted by W. G. Mollenkopf and S. D. Melville (12). Using data from the early 1950s, they sampled 206 school districts and a total of 17,957 ninth or twelfth grade students. Several independent variables representing the inputs and seven dependent variables representing the outputs were identified.

The output variables included achievement test scores, arithmetic reasoning and computation tests, and vocabulary test scores. Stepwise multiple regression techniques were used to analyze the responses from the ninth and twelfth grade classes. The results indicated that average class size and percentage of last year's graduates who went on to college were the most significant input variables.

In another study by J. A. Thomas in 1962 (18), 206 schools varying in communities from 2,500 to 25,000 in population were analyzed. Thirty-two independent and 18 dependent variables were analyzed. A stepwise multiple regression analysis technique was run for each of the 18 dependent variables. All independent variables were considered in every case. Independent variables that were consistently significant included class size, teacher starting salaries, expenditure per pupil, number of books in the library, average experience of teachers, median family income, average daily absentee rate, and percent of dropouts after entry into the tenth grade. Those independent variables that were insignificant most of the time were: number of study hall periods per week, provision for grouping, town population, unemployment rate in the town where the school was located, miles to the nearest large city, percent employment of white collar workers, and delinquency rate.

In 1968, Martin Katzman (10) analyzed data from 56 school districts in Boston, Massachusetts. Again, a stepwise multiple regression technique was used to analyze the input and output variables. The results of his study indicated that the size of the school area was significant and had influence on attendance rate, median scores, and completion rate. Teacher inexperience was insignificant in analyzing median scores and significant in terms of attendance rate, average daily attendance, and continuation rate.

Herbert Kiesling (11), in analyzing costs and quality of New York school districts in 1970, found that parents' educational level was highly significant in explaining scores for students using the Iowa Test of Basic Skills in the fifth and eighth grades. One hundred and twenty-seven different regression equations were analyzed. The educational level of the mother was significant in 48 of those equations. Other independent variables that helped explain the variability in achievement scores included teacher education, teacher experience, teacher salary, and pupils per teacher.

J. A. Coleman, in what has become known as the Coleman report (2), analyzed 645,000 students in 3,100 schools.[1] Schools were randomly chosen within a stratified sampling scheme. School resources were derived from questionnaires supplied to administrators. Background factors on students were derived by student questionnaires. Student outcomes were obtained from achievement scores on tests administered by the Educational Testing Service.

Ten dependent and 93 independent variables were identified. Independent variables were classified by six background factors, school facilities and curriculum, teacher characteristics, and student body characteristics. Students were classified by race and geographic area in the United States.

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[1]The Coleman report is a massive educational research document.

The six background factors accounted for 0 to 13% of the variance in the achievement of students in different regions. The seven teacher characteristics added about 1½ to 8% to the explanatory power of the equation. Adding the 11 school variables increased the regression's explanatory power from 1 to 3½%. Finally, adding the student body variables increased explanatory power by about 1½%. Overall, then, the production function accounted for about 20 to 26% of the variance in students' verbal achievement.

Marshall S. Smith (16) re-analyzed the data collected in the Coleman report. Smith argued that Coleman made two mechanical errors in analyzing the data. Measures of home background were inadvertently replaced, and an error in the estimation procedure for school-to-school differences was made. Nevertheless, some of Coleman's conclusions were verified, while others were not. Smith's study verified Coleman's conclusions on the influence of teachers' characteristics, school facilities, and curriculum. However, Smith found no evidence that the characteristics of the student body have a strong influence on verbal achievement of individual students.

Some studies have been conducted on educational production function analyses for educational programs outside of secondary schools. The next few paragraphs highlight some of this most recent work.

A recent study by Huffman (8) reviewed the productive value of human time in United States agriculture. His study focused on assessing the quantity and productivity of farm husband and wife labor services allocated to their own farm work. A behavioral model was developed to assess the actual value of human time and other inputs including education, agricultural extension, and agricultural production. Data were collected from 276 counties in Iowa, North Carolina, and Oklahoma. Agricultural extension agent time was considered as one component of the human time input in the model, and Huffman concluded that the marginal product of extension was large and in many cases in excess of $1,000 annually per day. His study concluded that the size of the return to agricultural extension was quite favorable and compared favorably with alternative uses of these funds.

Patrick and Kehrberg (14) looked at the cost and returns of education in five agricultural areas of eastern Brazil. Their study tested the hypothesis that education has a major role in agricultural development. By estimating costs and returns of schooling and extension in areas at various modernization levels, the results of this study indicated that the federal extension service in Brazil served areas where about 52% of the rural population was located. The estimated public cost of production oriented activities through the extension service was $120 per farm in 1968. From that, farmers estimated their costs in terms of time and out-of-pocket expenses in participation of extension activities at $31.07 per year or $3.22 per contact. Thus, the investment returns to agricultural extension were again quite high.

In summary, most studies conducted on the input/output relationships in agricultural education have focused upon student achievement test scores as the output variable with input variables related to teacher experience, education, socio-economic background, school expenditures, and the like. Multiple regression techniques have been the statistical technique used. Virtually no studies have attempted to integrate basic economic production function theory and educational response.

CHAPTER III. METHODS AND PROCEDURES

The purpose of this section is to describe the research methods and procedures used in this study. Included is a discussion of the data collection methods and the economic and statistical techniques used to analyze the data. The actual data analyses will be highlighted in the next two sections.

Study Area

The departments of agricultural education in the north central region of the United States were used as the data source for this study. The states included in this region are outlined on the map in Figure 3.1. The region is defined according to the regional boundaries as established by the Cooperative State Research Service of the United States Department of Agriculture (15). One exception to the regional boundaries should be noted. Alaska was excluded from the study, because Alaska does not have an agricultural education department in a land grant university. The states in the north central region included in the study are as follows: North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, Illinois, Michigan, Indiana, and Ohio.

The north central region was selected as the study area because of the large number of bachelor of science graduates from the programs in these states. As shown in Table 3.1, during the 1977-1978 academic year, 1,791 students graduated with a B.S. degree from an agricultural education department in the United States.

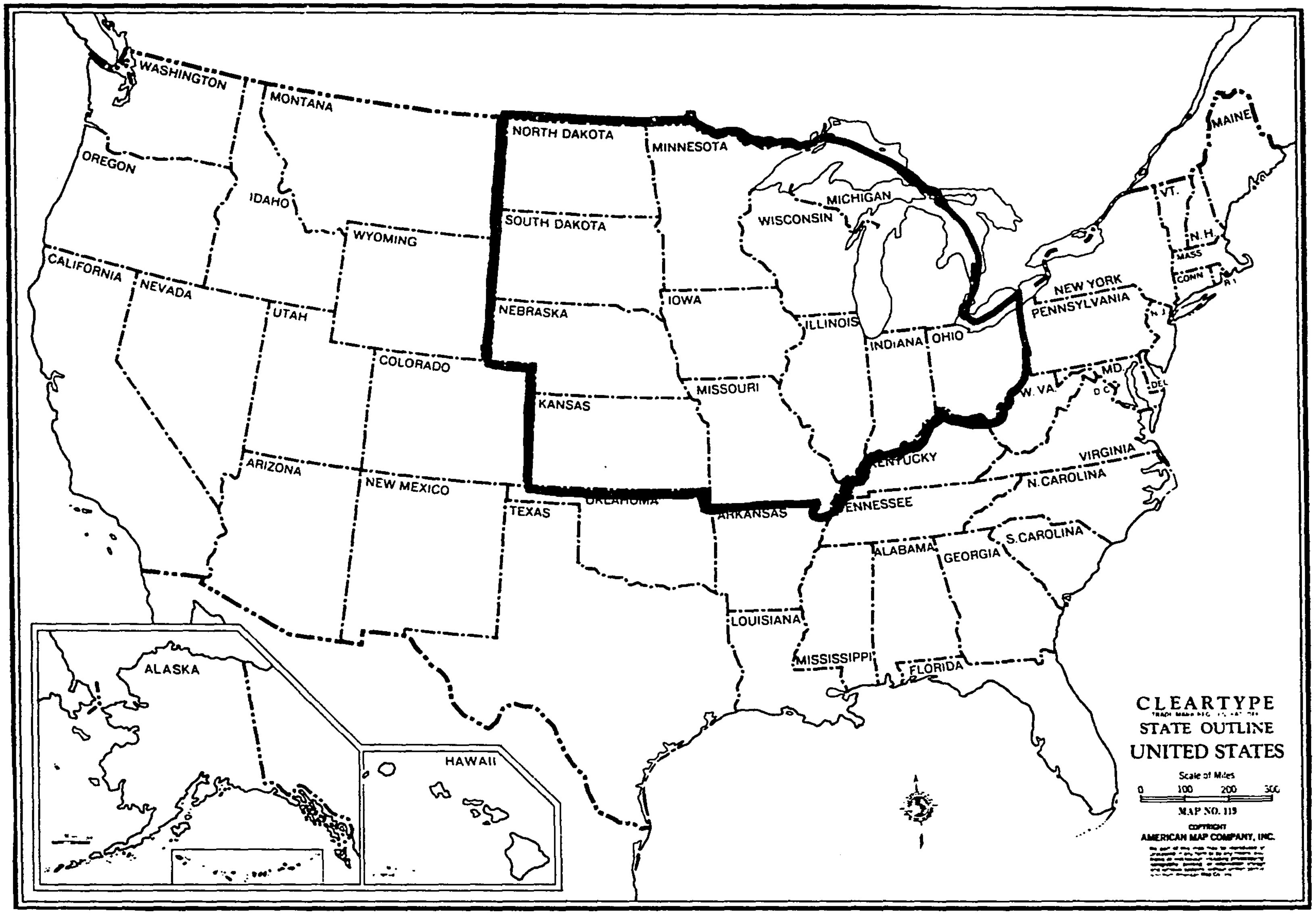

Figure 3.1. Map of the states in the north central region and study area

Table 3.1. Graduates in agricultural education, number entering vocational agriculture teaching, and percent of graduates entering teaching, 1977-1978 academic year[a]

Region	No. of B.S. graduates	Pct. of total graduates	No. entering teaching Vo.-Ag.	Pct. of total teaching	Pct. graduates entering teaching
North Atlantic	210	11.7	105	10.3	50.0
North central	623	34.9	391	38.6	62.8
Pacific	232	12.9	145	14.3	62.5
Southern	726	40.5	374	36.8	51.5
Total U.S.	1,791		1,015		56.7

[a]Source: (3).

Of that total, approximately 623 or 34.9% were from the north central region. While this is less than the southern region, there were more B.S. graduates from the north central region than the North Atlantic and the Pacific regions combined. This is indicative of the importance of agricultural education programs in the north central region. During the same period of time, the north central states placed more undergraduate students in vocational agriculture teaching as compared to the other regions in the United States. Three hundred and ninety-one graduates selected vocational agricultural teaching at the secondary level as their first job. This is approximately 17 more than the southern region, and more than twice the number placed by schools in the Pacific and North Atlantic regions. In percentage terms, 38.6% of the graduates entering teaching were from the north central region. This is more than any other region.

Another factor to indicate the importance of agricultural education in the north central region can be noted by the percentage of bachelor of science graduates entering teaching. The same data source indicates that approximately 63% of the B.S. graduates entered vocational agriculture teaching. This compares to 51.5% for the southern region and 62.5% for the Pacific region. Thus, the north central states placed a higher percentage of their graduates in vocational agriculture teaching as compared to the other regions.

The north central states were also selected because of the familiarity of the programs to the author, major professor, and some members of the study committee. The survey questionnaire was quite lengthy, and it was felt that by using these states, more reliable and accurate data could be obtained.

By using this method for delineation of the study area rather than a random sample of all agricultural education departments, only limited inferences can be made to other departments outside the region that would be statistically valid. However, it is hypothesized that the agricultural education programs are probably somewhat homogeneous across the United States; hence, some implications might be made.

Survey Method

The survey method was used to collect the data for this project. A mail survey was prepared and sent to the departmental executive officer in each land grant university in the north central region of the United States. A sample of the survey instrument is found in the Appendix.

The survey method for data collection was used for several reasons. It is less expensive than the interview method of data collection. Interviewing each departmental executive officer would have been more time consuming and more costly; however, more accurate data might have been obtained. For extremely large sample sizes, the survey method allows a researcher to use a larger data base as compared to the interview method. The mail survey method lends itself to ease of data collection and analysis, since a more uniform data set is generally obtained. All respondents answer the same questions, but missing data can occur with this method compared to personal interviews. Statistical techniques, however, are available to handle the problem of missing data.

The survey for the study was distributed to each departmental executive officer during mid-November, 1979, asking them to respond. Twelve questionnaires were mailed and responses were received from eight departments for a 66.7% completion rate.

Educational Production Function Procedures

The production function is a concept used by economists to explain physical and biological relationships. It has been extensively used by agricultural economists to explain input and output relationships in modern commercial agriculture. Researchers in physical and biological sciences have long conducted research on the nature and form of the agricultural production function. Attempts to incorporate production function concepts into education, particularly agricultural education, have been limited and done only recently. Several possible reasons exist to explain the lack of production function analyses in education. First, quantitative applied research in education is a relatively new and vastly unexplored field. It has only been within the last decade that quantitative studies have been conducted. Second, data gathering methods and procedures have been somewhat limited. With the development of more sophisticated methodologies utilizing computer technologies, educational scientists have been able to apply more sophisticated data gathering methods and model formulation. Nevertheless, the production function concept as an input-output model can be adapted to explain educational behavior.

One basic underlying assumption for an educational production function is that the function is an equally accurate description of the educational process for all students or at least for some identifiable subgroup of students. That is, the unit contribution of any given resource factor influencing student outcome is assumed to be approximately the same for all students. This assumption implies that if any particular resource factor does have a significant impact on student outcomes, the coefficient of that resource should be significant in any study that examines it. Otherwise every student must be different or respond differently to the same resource.

Student outcomes or the output from the production function are most often cognitive achievement measured by scores on standardized reading or mathematics achievement tests, particularly for secondary schools. Dropout rates, holding rates, or numbers of students are occasionally examined. Less frequently included in the student outcome is some measure of a college attendance or intention to attend.

More recently, educational production function studies have begun to investigate students' attitudes towards education.

Resources virtually always include measures of the quality of the secondary school's faculty. Average teachers' experience, salary, degree level, and verbal ability are commonly used. Average class size or student-teacher ratios appear often as well. Measures of the physical plant or facilities of the secondary school are also generally included in the educational production function. Other factors included as inputs in the production function are usually measures of the socio-economic status of the students' families or of the communities their school serves. Examples are average family income, educational attainment of the parents, and the occupation of parents.

The most serious difficulty faced by the production function approach is rooted in the source of data used in the empirical analysis. Therefore, this approach has been plagued by many severe analytical problems. Educational effectiveness using the production function approach relies upon natural experiments for its empirical content. That is, no production function studies have been based upon observation or true experiments.

A second major problem that confronts researchers using the input-output approach stems from data aggregation. The researcher would like to examine the relationship among the school resources an individual student receives, his background and other factors on one hand, and his educational outcome on the other. But data are almost never available in such detail. The researcher generally has data available only in much more aggregated form.

Formulation of educational production function

The educational production function is a mathematical relationship between educational resources (inputs) and educational outcomes (outputs). It can be expressed in the following mathematical relationship:

$$Y = f(X_1, \ldots X_k, X_{k+1} \ldots X_{k+m}, X_{k+m+1} \ldots X_n).$$

Y in this equation represents the educational output from the production process. The output is often measured in terms of student achievement based upon standardized achievement tests, dropout rates, percentage completion of educational process, percentage graduates entering a professional field upon program completion, or other educational factors related to the performance of the educational system. It could also be measured in terms of numbers of graduates, number of students, or number of students entering a specific field of study. The inputs into the production function are represented by the variables X_1 to X_n. These variables can be divided into three major parts. The variables X_1 to X_k might represent the physical amounts of educational resources used in the system. Some examples are staff time, salaries, related costs, class size, library books, classroom space, etc. The variables X_{k+1} to X_{k+m} might represent the background factors of the student. Examples might include father's income, father's occupation, school activities, and other related items. The last set of variables might represent the influence of peer groups, particularly peer groups that the student has been exposed to such as the proportion of students that intend to go to college from a secondary school, the proportion of classmates that are of minority groups, etc.

This educational production function, as expressed in general terms, states that for any particular educational system there is a relationship between the inputs of the system and the output. The exact nature of the function and selection of the output and input variables depends upon the research problem to be solved. In order to make a quantitative estimation of the function, a precise mathematical relationship must be described.

Linear production function Many studies using an educational production function have specified a linear functional form. This is a reflection upon limited statistical analysis techniques rather than a consensus about the form of the production function. The linear production function assumes that each unit of input contributes a constant amount to the output. The unit contribution of any one input does not vary with the amount of that input used in the production process. An example of a linear production function might be as follows:

$$Y = f(X)$$

where

Y = output

X = input.

Suppose the production function is defined to be $Y = 2X$, then if one unit of X is used, the output forthcoming is 2 units. For 2 units of X, Y is equal to 4. For 3 units of X, Y is equal to 6 units.

This linear production function can be graphed as shown in Figure 3.2.

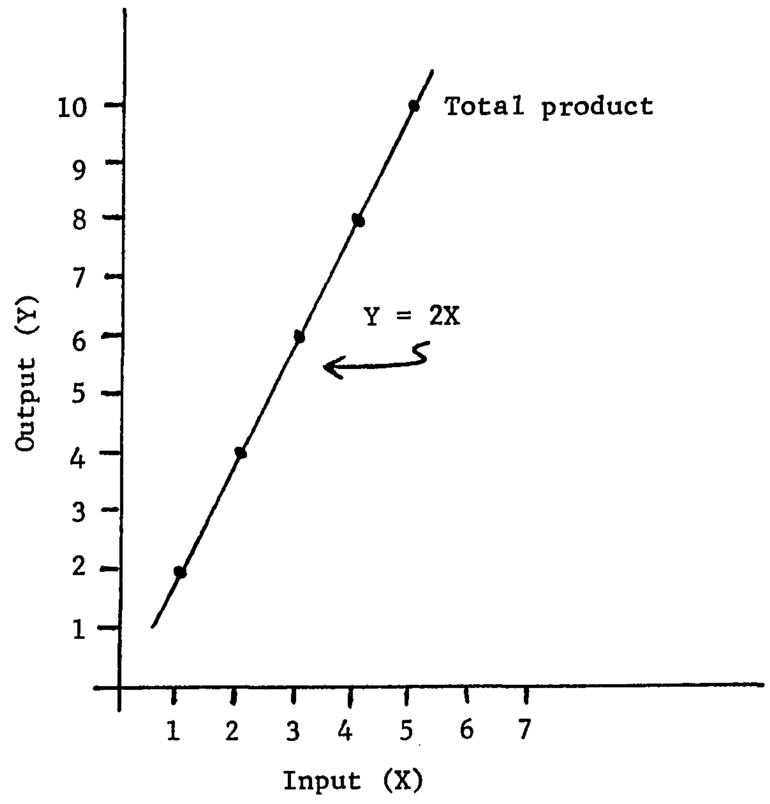

Figure 3.2. Graphical analysis of a linear production function where the function is described as Y = 2X

From the production function, more specifically, the total product curve, the marginal and average contribution of each quantity of input can be determined. The average product (AP) is the quantity of product per unit of input with the quantity of input set at some level. Mathematically, it is total product divided by units of input required to obtain that production.

Marginal product (MP) is the increase or decrease in total product as the level of input increases by one unit. It shows the addition to total production (marginal change) as inputs change. Mathematically, it is the change in total production divided by the change in input.

Table 3.2 shows the average and marginal product for the linear production function, $Y = 2X$.

Table 3.2. Average and marginal products for the linear production function, $Y = 2X$

Input (X)	Total product (Y)	Average product	Marginal product
1	2	2	
2	4	2	2
3	6	2	2
4	8	2	2
5	10	2	2

From Table 3.2, it is apparent that marginal product equals average product as the level of inputs changes. Also, average and marginal product are constant over the entire range of inputs. Thus, for each additional unit of input added, the marginal contribution of the inputs to outputs will always be the same; hence, there is no increasing or decreasing marginal productivity for the linear production function as the quantity of inputs increases.

For a linear production function with more than one input, the production function might be specified as

$$Y = a + b_1X_1 + b_2X_2 + \ldots + b_nX_n.$$

As noted before, Y denotes the output from the production process. b_1 through b_n denote the unit contribution of each factor of production (X_1 to X_n).

The objective of the production function research then is to estimate the values of b_1 through b_n. If these values are known, then the impact of providing more or less of any particular resource can be determined. This allows one to determine whether increasing or decreasing the amount of any educational input will affect the output more or less than increasing or decreasing the amount of another input.

Multiple regression analysis is used to estimate the values of the coefficients, namely the b_1 through b_n in the above equation. Multiple regression analysis provides for tests of significance of the empirical results. These are formal measures of the accuracy of the results in the sense that they indicate how much confidence can be placed in them.

Curvilinear production function While many studies have utilized a linear educational production function, there are other production function estimations that can be made. One possibility is a curvilinear production function with linear inputs. The basic assumption of this production function is that each unit of input does not necessarily contribute a constant amount to the output. The unit contribution of any one input can vary with the amount of that input that is used in the production process. Hence, the marginal productivity of the input does not remain constant, and there can be increasing or decreasing marginal productivity as the quantity of input increases or decreases.

Table 3.3 shows the mathematical relationship between inputs and total product (output) for a hypothetical production function. The same data from Table 3.3 are graphed in Figure 3.3.

From the data in Table 3.3 and Figure 3.3, it is apparent that the total product (Y) begins at zero, increases at an increasing rate, then increases at a decreasing rate, and finally declines.

Table 3.3. Total products, marginal and average product for a hypothetical curvilinear production function with linear inputs

Input (X)	Total product (Y)	Average product (AP)	Marginal product (MP)
0	0	0	0
2	15	7.50	7.50
4	50	12.50	17.50
6	90	15.00	20.00
8	150	18.75	30.00
10	190	19.00	20.00
12	220	18.33	15.00
14	240	17.14	10.00
16	250	15.63	5.00
18	255	14.17	2.50
20	240	12.00	-7.50

From this relationship, several other relationships to marginal and average product can be determined.

When the production function changes from increasing at an increasing rate to increasing at a decreasing rate, the quantity of product makes its greatest increase with respect to a change in input. Therefore, the slope of the production function is at its greatest and marginal product is maximum where production changes from increasing at an increasing rate to decreasing rate.

Two other relationships are worth noting also. From Figure 3.3, it should be observed that when marginal product is increasing, average product is also increasing and that marginal product is greater than average product. By the same token, when average product is decreasing, marginal product is also decreasing, and average product is greater than marginal product.

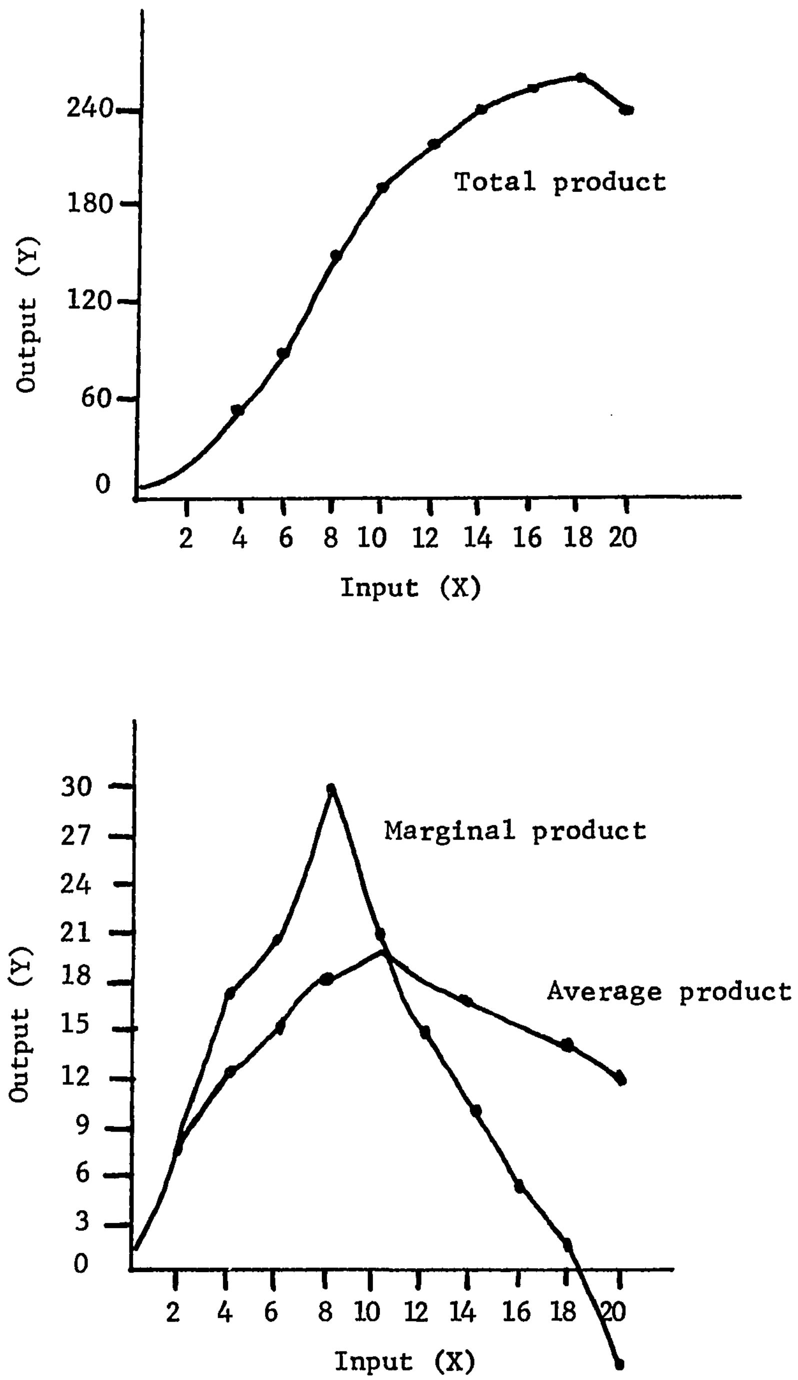

Figure 3.3. Graphical analysis for a hypothetical curvilinear production function with linear inputs

Marginal product and average product will be equal when average product is at its maximum. The amount added to total product by an incremental change in the input is the same as the total product per unit of input when marginal product equals average product.

The production function provides sufficient information for decision-making without knowledge of costs and returns. For example, it would be irrational to use a quantity input that would decrease total production. In the hypothetical example, one would not use 20 units of X, because total product decreases as X is increased from 18 to 20 units. It is also irrational to limit an input to a level where average product is still increasing. Average productivity is increasing, and if it pays to use an input, it certainly would pay to use that input up to a point where its average productivity is at a maximum (up to 10 units in this example). This leaves one area where rational production should occur, and that is the area from where average product is at a maximum (or marginal product equals average product) to where total product is at a maximum or marginal product equals zero.

Several examples of curvilinear production functions can be found in the literature. A few examples are mentioned and discussed in the next few paragraphs. For a complete discussion of the various forms of production functions, the reader is referred to Heady and Dillon (6).

One example of a curvilinear production function is the Cobb-Douglas function as described in the following equation:

$$Y = aX_1^{b_1} X_2^{b_2} \ldots X_n^{b_n}q.$$

The marginal product for X_1 is:

$$\frac{\partial Y}{\partial X_1} = b_1 \left[aX_1^{b_1-1} X_2^{b_2} \right] q.$$

The average product for X_1 is:

$$\frac{Y}{X_1} = \frac{aX_1^{b_1} X_2^{b_2} \ldots X_n^{b_n} q}{X_1}$$

$$= aX_1^{b_1-1} X_2^{b_2} \ldots X_n^{b_n} q.$$

As with the linear function, the objective of using this function is to estimate the values of b_1 through b_n. This allows one to determine how much the output will vary by increasing or decreasing the input by one unit.

Multiple regression techniques may also be applied directly to estimate the parameters of this production function. To do this, there must be a transformation of the production function into a linear form. By expressing each of the input variables and also Y in terms of logarithms, either natural or to the base ten, a linear function is obtained. Thus, the production function is transformed as shows:

$$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + \ldots + b_n \log X_n + \log q.$$

From this equation, it is possible to use multiple regression analysis techniques to estimate the Cobb-Douglas production function.

Several examples of a Cobb-Douglas production function exist. The original work of Cobb and Douglas (1) used manufacturing output as the dependent variable and capital and labor in the industry as inputs. Cobb-Douglas production functions have been used by Heady and Dillon (6) to explain biological relationships in livestock production, such as corn-soybean meal combinations in swine rations. Also, rations for feedlot cattle have been tested using the Cobb-Douglas function.

The quadratic form of a production function does allow for diminishing returns, while the Cobb-Douglas function does not. The mathematical relationship for a quadratic function for two inputs can be described as follows:

$$Y = a + b_1X_1 + b_2X_2 - b_3X_1^2 - b_4X_2^2 + b_5X_1X_2.$$

Diminishing marginal products are observed for either factor alone, but there is a positive interaction between the two inputs. The marginal products are:

$$\frac{\partial Y}{\partial X_1} = b_1 - 2b_3X_1 + b_5X_2$$

$$\frac{\partial Y}{\partial X_2} = b_2 - 2b_4X_2 + b_5X_1.$$

The average product for X_1 is:

$$AP = \frac{Y}{X_1} = \frac{[a + b_1X_1 + b_2X_2 - b_3X_1^2 - b_4X_2^2 + b_5X_1X_2]}{X_1}.$$

As with the Cobb-Douglas function, the quadratic function can be estimated through multiple regression analysis techniques. It is not necessary to transfer the function into a linear form for estimation. The b's can be estimated directly.

The square root function is a compromise between the quadratic and the Cobb-Douglas function. It is expressed in the following equation:

$$Y = a - b_1X_1 - b_2X_2 + b_3X_1^{.5} + b_4X_2^{.5} + b_5X_1^{.5}\,X_2^{.5}.$$

It possesses some of the characteristics of both the Cobb-Douglas function and quadratic function.

Heady and Dillon (6) have used both the quadratic and square root functions to estimate crop yield responses to fertilizer. Most notably, the response of corn yield to nitrogen has been tested, and both the square root and quadratic functions have explained the yield response of corn to nitrogen fertilizer.

Later sections of this study will take some of the data collected and attempt to fit an educational production function using a Cobb-Douglas, a quadratic, and square root formulations. The undergraduate program in agricultural education will be used as a basis for this analysis.

CHAPTER IV. DESCRIPTIVE RESULTS

This chapter describes empirically the descriptive results of the survey from the agricultural education departments. Tables and charts are included highlighting resource use, demographic and experience data about the staff, and departmental performance as measured in numbers of graduates. The study departments are classified into two size groups based upon undergraduate student enrollment, and statistical differences for selected variables are contained in this section.

General Descriptive Information

Information was collected from each departmental executive officer on its organizational structure, college affiliation, instructional system, and degree programs offered. These data are summarized in Table 4.1.

The department heads or chairpersons were asked to indicate how their program was organized and identified within the total university system. Respondents could either reply that their program is a recognized department within the total university or a section within a larger department. As shown in Table 4.1, the respondents are equally divided between both cases. One-half of the curricula is organized as a department within a college of the university, and the other half as a section within a larger department.

Departmental executive officers indicated their departmental affiliation to a particular college within the university. There is no uniformity among the study departments. Some are organized as

Table 4.1. General descriptive information regarding the agricultural education programs of selected land grant universities in the north central region, 1978-1979

	Land grant university									
	Iowa State Univ.	Univ. of Ill.	Univ. of Minn.	Univ. of Mo.	Univ. of Nebr.	N.D. State Univ.	Purdue Univ.	S.D. State Univ.	Total	Pct. total
1. Departmental organization										
a. Department within a college	x				x	x		x	4	50.0%
b. Section within a department		x	x	x			x		4	50.0%
2. Departmental affiliation										
a. College of agriculture only						x			1	12.5%
b. College of agriculture but staff appointments in college of education	x				x				2	25.0%
c. College of education only		x						x	2	25.0%
d. College of education but staff appointments in college of agriculture			x	x			x		3	37.5%
3. Instructional system										
a. Quarter system	x		x			x				37.5%
b. Semester system		x		x	x		x	x		63.5%

Table 4.1. (Continued)

	Land grant university: Iowa State Univ.	Univ. of Ill.	Univ. of Minn.	Univ. of Mo.	Univ. of Nebr.	N.D. State Univ.	Purdue Univ.	S.D. State Univ.	Total	Pct. total
4. Teaching system for "quarter system" departments										
a. Usual length of academic quarter	10 wks.		10 wks.			10 wks.				
b. One hour of class time per week equivalent to one hour of college credit	x					x	x			
c. Usual length of lecture classes	50 min.					50 min.	45 min.			
d. Usual length of laboratory classes	100 min.					100 min.	90 min.			
5. Teaching system for "semester system" departments										
a. Usual length of academic semester		16 wks.		16 wks.	15 wks.		16 wks.	17 wks.		
b. One hour of class time per week equivalent to one hour of college credit		x		x	x		x	x		
c. Usual length of lecture classes		50 min.		50 min.	50 min.		50 min.	50 min.		
d. Usual length of laboratory classes		100 min.		100 min.	110 min.		80 min.	100 min.		

Table 4.1. (Continued)

	Land grant university									
	Iowa State Univ.	Univ. of Ill.	Univ. of Minn.	Univ. of Mo.	Univ. of Nebr.	N.D. State Univ.	Purdue Univ.	S.D. State Univ.	Total	Pct. total
6. Degree programs offered										
B.S. in agricultural education	x	x	x	x	x	x	x	x	8	
B.S. in agricultural extension education								x	1	
M.A. or M.S. in agricultural education -- non-thesis	x	x	x		x	x			5	
M.A. or M.S. in agricultural education -- thesis	x		x		x	x			4	
M.S. in agricultural ext. education -- non-thesis										
M.S. in agricultural ext. education -- thesis										
M.S. or M.A. in education			x				x		2	
Ph.D. in agricultural education	x			x					2	
Ph.D. in agricultural ext. education										
Ph.D. in education		x	x		x		x		4	
Other		--[a]		--[b]		--[c]		--[d]	4	

[a]Master of education; advanced certificate in education.

[b]M.A. - thesis; M. Ed. - non-thesis; Ed. S. - Specialist.

[c]M.S. in general agriculture.

[d]M. Ed. in agricultural education.

a department within the college of agriculture, while others are organized as a department within the college of education. Three departments are organized and affiliated with the college of agriculture, with two of these having staff with joint appointments in the college of education. The opposite is true in three cases.

There seems to be some correlation between departmental organization and departmental affiliation. For those curricula organized as departments, they are more closely aligned with the college of agriculture. Three of the four departments organized in this manner are affiliated with the college of agriculture. Likewise, those departments organized as a section are more closely aligned to the college of education. These data would suggest that no commonality exists among the study departments even though the major mission of each department is the same.

The semester system tended to dominate the instructional system used. Only three of the study departments are using the quarter system. These are Iowa State University, the University of Minnesota, and South Dakota State University. Iowa State University will be changing to the semester system in the fall of 1981. It should be noted that the instructional system being used is determined by the whole university with the agricultural education department having limited power in making that determination.

Respondents using either system were asked to indicate the normal length of an academic quarter or semester, the usual length of lecture and laboratory class sessions, and the equivalency between class time and college credits. These responses are found in Table 4.1.

Some variability existed in length of semesters, but at most universities the semester contains 15 to 17 weeks with an average more nearly 16 weeks. Likewise, most academic quarters tended to be 10 weeks (approximately two-thirds the length of a semester). Class and laboratory time are uniform among both the semester and quarter systems. Approximately 50 minutes is the usual length of a lecture class, while laboratory classes vary from 80 to 110 minutes.

Some variation is found in the degree programs offered. These seemed to be correlated to the departmental affiliation and organization. All of the departments offer a bachelor of science degree in agricultural education, since this degree is a necessary prerequisite for teaching vocational agriculture at the secondary level. Advanced degree programs are available from some of the study departments. More than 50% offer a master of science degree in agricultural education with either a non-thesis or thesis option. None of the departments currently offered a master of science in agricultural extension education. At the same time, only two departments offered a Ph.D. in agricultural education. Four departments offered a Ph.D. in education.

Table 4.2 lists the demographic and background data on the faculty and staff for the study departments. Departmental executive officers listed the number of faculty and staff including graduate assistants and demographic data such as sex, age, educational background, and tenure. These are summarized by department. As shown in Table 4.2, there is a considerable range in the number of faculty and staff in each department ranging from three to 17 staff members with a mean of 8.75 staff per department. The staff in the study departments

Table 4.2. Demographic and background data on faculty and staff in the study departments

Land grant university	Number faculty /staff	Sex		Mean age	Degrees completed			Percent faculty tenured
		Percent male	Percent female		Percent B.S.	Percent M.S.	Percent Ph.D.	
Iowa	13	84.6	15.4	35.3	100.0	100.0	46.0	50.0
Illinois	12	91.7	8.3	41.2	100.0	83.0	33.0	33.0
Minnesota	8	100.0	-0-	48.2	100.0	100.0	100.0	100.0
Missouri	17	88.2	11.8	34.7	100.0	100.0	23.5	40.0
Nebraska	9	100.0	-0-	38.0	100.0	67.0	67.0	57.1
North Dakota	4	100.0	-0-	39.5	100.0	75.0	50.0	25.0
Purdue	4	100.0	-0-	38.5	100.0	100.0	100.0	75.0
South Dakota	3	100.0	-0-	49.7	100.0	100.0	100.0	100.0
Mean	8.75	95.56	4.44	40.63	100.0%	90.63%	64.94%	60.0%

is predominantly male, with slightly less than 5% of the total being female. The average age of all staff is slightly over 40 years, with all of the staff members completing a bachelor of science and nearly all a master of science degree. Slightly more than 60% of the staff had attained a Ph.D. degree. Faculty and staff data include instructors and graduate assistants working on an advanced degree at the same time as their employment within a department, and this explains why only 60% of all staff are tenured.

The years of experience of the faculty and staff is found in Table 4.3. Experience in years is classified several ways -- total years of professional experience, years of university teaching experience, years of high school teaching experience, and years of experience since last degree. The mean for each category is plotted on the bar graph found in Figure 4.1.

For the study departments, the average years employed within their respective program is slightly more than six years. It varied from a low of 3.24 years to a high of 11.00 years. The number of years of university teaching experience tended to be closely related to the number of years employed in the present department; however, it is doubtful that any meaningful conclusion can be drawn from this relationship.

The years of total experience varied from a high of 25.7 years to a low of 8.29 years with a mean of 16.1. The years of total experience is not the sum of the years of high school experience plus university experience, as many staff may have had other professional experience outside of teaching.

Table 4.3. Years of experience by various classifications for faculty and staff in the study departments, 1978-1979

Land grant university	Years employed in present department	Years of professional experience since last degree	Years of high school teaching experience	Years of university teaching experience	Years of total experience
Iowa	5.00	5.85	4.15	5.85	11.54
Illinois	6.25	11.00	5.67	6.67	16.92
Minnesota	13.38	14.25	5.88	16.12	23.38
Missouri	3.24	5.65	4.41	3.53	8.29
Nebraska	3.78	6.67	5.22	5.56	14.89
North Dakota	4.25	7.50	7.50	5.56	14.89
Purdue	5.75	6.50	6.75	6.75	13.50
South Dakota	11.00	9.0	15.0	12.70	25.70
Mean	6.58	8.05	6.82	7.84	16.14

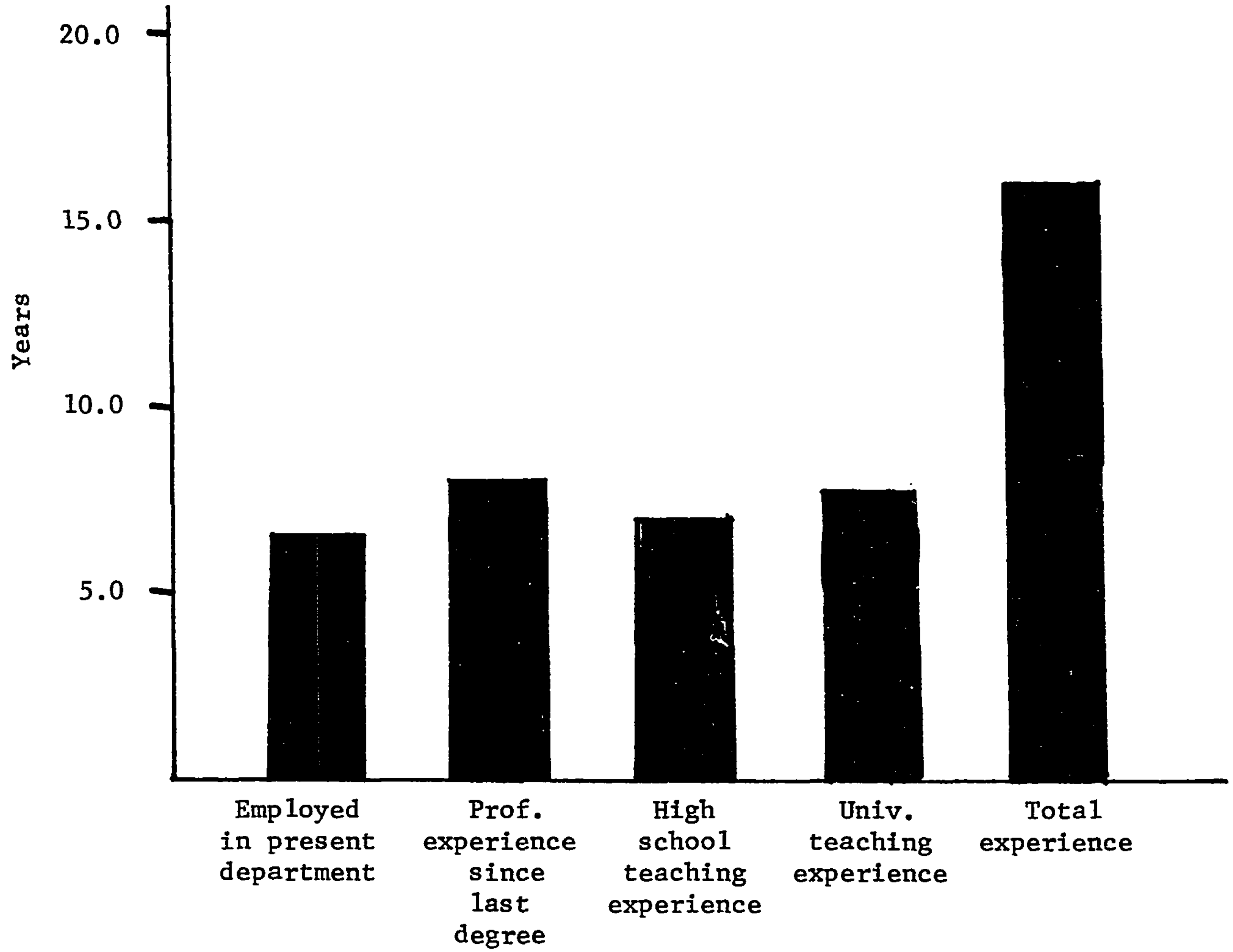

Figure 4.1. Mean years of experience by various categories for the study departments, 1978-1979

It is interesting to note from Table 4.3 that the mean years of high school teaching experience was almost the same as the mean years of university experience. Nearly all respondents indicated that the majority of their staff had high school teaching experience, indicating that many staff members started teaching in high school after completing a degree and then entered graduate school for advanced training.

Output Factors and Their Measurement

Output factors in the study include the number of students, number of graduates and their placement into employment, semester credit hours, and semester credit contact hours. A discussion of these follows.

Graduates and their placement

Economic output of the study departments is represented by the number of graduate and undergraduate degrees conferred by each department along with the placement of graduates, since the primary mission of the department is placement of teachers in schools. The numbers of students graduating and placement pattern can then be compared to the resource inputs used; namely, staffing and costs.

Figure 4.2 indicates the number of bachelor of science degrees conferred by each study department and the first job of each graduate. Figure 4.3 gives the same for all advanced degrees -- master of science and doctor of philosophy.

Two important output measures are identified from Figures 4.2 and 4.3. First, the absolute number of graduates is one output factor

Type of employment	Land grant university																Totals	
	Iowa		Illinois		Minnesota		Missouri		Nebraska		North Dakota		Purdue		South Dakota			
	No.	Pct. total	No.	Pct. total	No.	Pct. total	No.	Pct. total	No.	Pct. total	No.	Pct. total	No.	Pct. total	No.	Pct. total	No.	Pct. total
Vocational ag. teaching	38	59.4	10	50.0	23	62.15	25	65.9	16	47.0	19	67.9	22	73.4	11	45.8	164	59.6
Post-secondary teaching	1	1.6	1	5.0			1	2.6							1	4.2	4	1.5
Ag. extension			1	5.0	1	2.70	2	5.2			2	7.1	1	3.3			7	2.5
Agri-business	13	20.3	4	20.0	6	16.22	2	5.2	4	11.8	2	7.1	3	10.0	6	25.0	40	14.5
Farming	7	10.9			3	8.11	5	13.3	9	26.5	2	7.1	1	3.3	4	16.7	31	11.3
Graduate school			1	5.0	2	5.41	2	5.2	5	14.7			3	10.0	2	8.3	15	5.5
Other	5	7.8	3	15.0	2	5.41	1	2.6			3	10.7					14	5.1
Totals	64	100.0	20	100.0	37	100.0	38	100.0	34	100.0	28	100.0	30	100.0	24	100.0	275	100.0

Figure 4.2. Number of bachelor of science graduates and their job placement for the study departments, 1978-1979

Type of employment	Land grant university																Totals	
	Iowa		Illinois		Minnesota		Missouri		Nebraska		North Dakota		Purdue		South Dakota			
	No.	Pct. total	No.	Pct. total	No.	Pct. total	No.	Pct. total	No.	Pct. total	No.	Pct. total	No.	Pct. total	No.	Pct. total	No.	Pct. total
Vocational ag. teaching (secondary)	7	43.8	9	56.2	5	45.4	15	60.0	3	42.9			45	86.6	2	100.0	84	64.1
Ag. teaching (post-secondary)	2	12.5	2	12.5			3	12.0	1	14.3	1	50.0					9	6.9
University	2	12.5	1	6.3			3	12.0	1	14.3			1	1.9			10	7.6
Graduate school			1	6.3													1	.8
Agricultural extension	3	18.7	1	6.3	3	27.3			2	28.5	1	50.0	2	3.8			12	9.2
Agricultural business	2	12.5			1	9.1	1	4.0					3	5.8			7	5.3
Farming							2	8.0					1	1.9			3	2.3
Other			2	12.5	2	18.2	1	4.0									5	3.8
Totals	16	100.0	16	100.0	11	100.0	25	100.0	7	100.0	2	100.0	52	100.0	2	100.0	131	100.0

Figure 4.3. Number of master of science and doctor of philosophy graduates and their job placement for the study departments, 1978-1979

that can be used to measure departmental success. Second, the number of graduates entering teaching is important, but the rate at which they enter the profession is equally or more important. The entry rate or the percentage of students entering teaching is then a measure of departmental success. The entry rate at the undergraduate level is measured by calculating the percentage of graduates entering vocational agriculture teaching in secondary schools.

From Figure 4.2, the entry rate at the undergraduate level for the eight departments collectively was slightly less than 60% in 1978-1979. The entry rate varied from a low of 45.8% to a high of 73.4%. A total of 164 bachelor of science graduates out of a total of 275 graduates entered teaching. The second most popular career choice was agribusiness (14.5%) followed by farming (11.8%). These two vocational choices summed together represented less than half of the number of graduates entering vocational agriculture teaching. That is, more than twice as many graduates entered vocational agriculture teaching as compared to the second and third occupational choices combined. The remaining occupational choices, namely post-secondary teaching, extension, graduate school, and others, represented less than 15% of the total number of graduates.

For advanced degree candidates, vocational agriculture teaching was an important vocational preference, as shown in Figure 4.3. For the 1978-1979 graduates, 84 graduates representing 64.1% of the total went to vocational agriculture teaching at the secondary level. Many of these graduates were already teaching in high schools and then returned to the university to attend graduate school either full time or part time and upon graduation returned to their previous place of employment or similar employment in another school. The second most popular vocational choice was extension work with 12 students (9.2%) selecting that choice. The third choice was university teaching with many of the students being doctoral graduates entering into teacher education programs.

Semester credits and semester credit contact hours

As noted earlier, the undergraduate and graduate teaching programs are a very important phase of the total educational mission of each department. Measuring the output from the use of these resources seems justified. Two statistics used are the number of credits taught and the number of semester credit contact hours. Departmental executive officers were asked to list the undergraduate and graduate courses taught in 1978-1979 including the number of credits and the number of students completing the course. For the schools reporting on the quarter system, the data are converted to the semester system by taking the number of quarter credits and multiplying by 66.67%. Therefore, three quarter credits are equivalent to two semester credits. The number of semester credits and the number of semester credit hours were then aggregated by the undergraduate and graduate programs. The data are summed by department and shown in Table 4.4.

For the undergraduate program, the number of semester credits varied from a low of 24 to a high of 69. The number of semester credit contact hours varied from 331 to 1,254 credit hours. The mean number of semester credits for the eight study departments is

Table 4.4. Number semester credits and semester credit contact hours for the undergraduate and graduate programs in the study departments, 1978-1979

Land grant university	Undergraduate		Graduate		Total	
	No. semester credits	No. semester contact hours	No. semester credits	No. semester contact hours	No. semester credits	No. semester contact hours
Iowa	69	1,131	45	830	114	1,961
Illinois	24	425	44	496	68	921
Minnesota	45	1,101	47	618	92	1,719
Missouri	53	910	43	391	96	1,301
Nebraska	53	1,254	30	237	83	1,491
North Dakota	56	877	30	108	86	985
Purdue	28	331	49	355	77	686
South Dakota	33	535	7	88	40	623
Totals	361	6,564	295	3,123	656	9,687
Mean/department	45.1	820.5	36.9	390.4	82	1,210.9

45 with a mean semester credit contact hours of 820. Similarly, for the graduate program, the number of semester credits varied from a low of 7 to a high of 49. The range in graduate credits is due to the differences in graduate programs offered by each department. Some departments offered more graduate programs than others. The mean number of graduate credits offered is 37, with an average of 390 semester credit contact hours. Summing the undergraduate and graduate program reveals a mean of 82 semester credits for the year and 1,210 semester credit contact hours.

Input Factors and Their Measurement

Economic input factors in the production process represent capital in terms of salaries and labor in terms of staff time. Also, contributing to the process is the fixed plant itself; that is, the university classroom, laboratory, and related facilities. Data were collected on several input factors and are presented in the following sections.

Sources of funding

Agricultural education departments in the land grant system typically receive their sources of funds from both governmental and non-governmental sources. Governmental sources include funds appropriated by the state governing body appropriated directly to the university. Funds may also be appropriated by the same body and channeled through a state agency in charge of secondary and post-secondary education usually known as the State Department of Public Instruction. Agricultural education departments then either receive these funds directly from the Department of Public Instruction or by a contractual arrangement. Funds appropriated directly to the university are usually designated for specific purposes -- teaching, research, or in-service/extension. The funds for research are usually appropriated through the agricultural and home economics experiment station if the department is affiliated with the college of agriculture. These funds are used for research projects sponsored by the department. In addition, departments may receive funding from the federal government to be used in research and teaching. Non-governmental sources of funds include grants, gifts, and contracts from private companies, foundations, and similar sources.

Figures 4.4 and 4.5 show the sources of these funds for 1978-1979. Five major categories are identified. They are: state appropriated funds for teaching and extension purposes, state appropriated funds through the Department of Public Instruction, state and federal funds through the agricultural experiment station, other federal funds, and lastly, non-governmental funds including grants, gifts, and contracts. The total dollars received by each department and the percent of total are listed in Figure 4.4. Figure 4.5 is a pie chart showing the percentage distribution for each major category for all departments. From Figure 4.4, it is apparent that the largest source of funds available to the departments is state appropriations for teaching and in-service. These accounted for more than 73.0% of the total, followed by agricultural experiment station funds for research projects. Research funds through the experiment station amounted to 9.5% of the total. The Department of Public Instruction funds

Sources of funds	Land grant university: Iowa Amt.	Iowa Pct. total	Illinois Amt.	Illinois Pct. total	Minnesota Amt.	Minnesota Pct. total	Missouri Amt.	Missouri Pct. total	Nebraska Amt.	Nebraska Pct. total	North Dakota Amt.	North Dakota Pct. total	Purdue[a] Amt.	Purdue[a] Pct. total	South Dakota Amt.	South Dakota Pct. total	Grand totals	Pct. total
State, excl. ag. exp. sta.	164400	61.1	127100	91.4	301476	70.3	167881	68.7	171379	73.9	109695	94.0	82390	85.1	48112	82.4	1,172,433	73.9
State, D.P.I.	31200	11.6					74885	30.7							6050	10.3	112,135	7.1
Ag. exp. sta.	73318	27.3			3169	.7	1500	.6	60664	26.1	7003	6.0			4250	7.3	149,904	9.5
Federal, U.S. Government			12000	8.6									14475	14.9			26,475	1.7
Other, non-governmental					124000	29.0											124,000	7.8
Totals	268918	100.0	139100	100.0	428645	100.0	244266	100.0	232043	100.0	116698	100.0	96865	100.0	58412	100.0	1,584,947	100.0

[a]Some funds are used to support research but not included in departmental budget.

Figure 4.4. Sources of funds including state, federal, and non-governmental sources for the study departments, 1978-1979

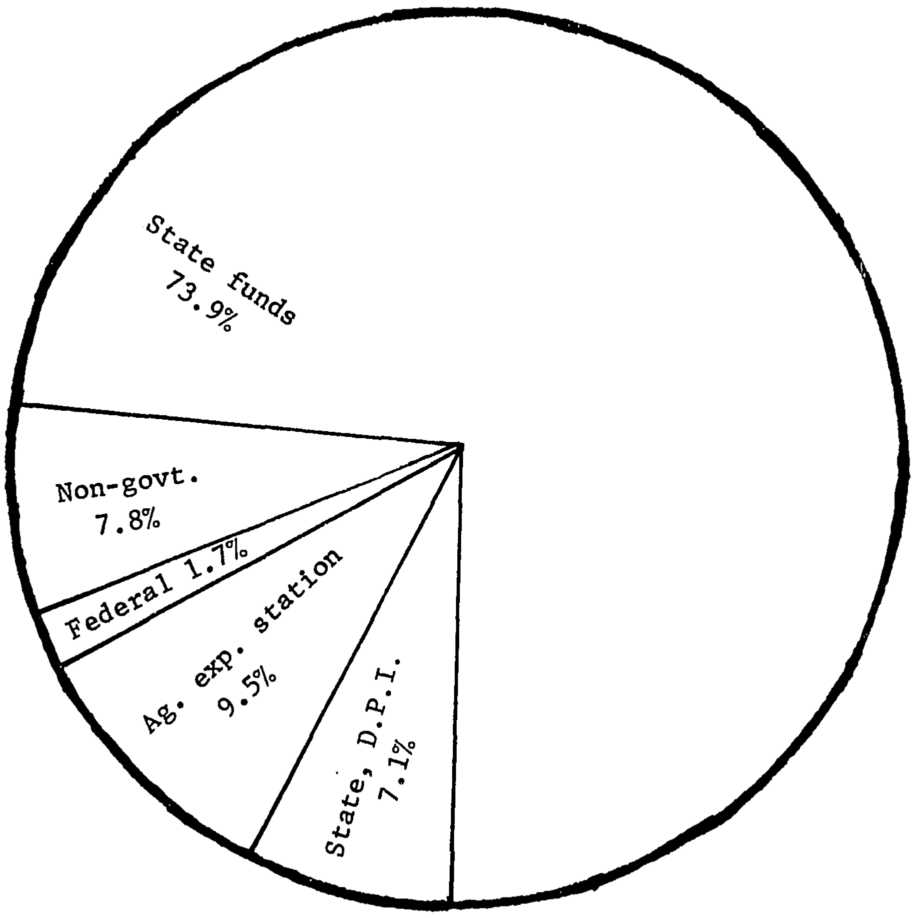

Figure 4.5. Percentage distribution of the sources of funds for the study departments, 1978-1979

accounted for 7.1% of the total, while other funds amounted to a very small amount.

Faculty and staff time utilization

An important resource to the agricultural education program at each land grant university is the faculty and staff. Departmental executive officers were asked to list all professional faculty, graduate teaching assistants, and research assistants for the 1978-1979 calendar year. Support staff such as secretarial or clerical were not included. Respondents were also asked to indicate the type of appointment held by each faculty/staff member. The type of appointment refers to the amount of employment time as designated by the university. Two key factors are included in this designation -- the months employed and the time required to be on the job as specified by the university. These two factors combined together give the employment base. Departmental executive officers then indicated the employment base for each faculty/staff member according to the following designations:

A = Full time, 12 months, instructor or professorial
3/4 A = 3/4 time, 12 months, instructor or professorial
1/2 A = 1/2 time, 12 months, instructor or professorial
B = full time, 9 months (academic year), instructor or professorial
3/4 B = 3/4 time, 9 months (academic year), instructor or professorial
1/2 B = 1/2 time, 9 months (academic year), instructor or professorial
C = full time, 12 months, graduate assistant
3/4 C = 3/4 time, 12 months, graduate assistant
1/2 C = 1/2 time, 12 months, graduate assistant
1/4 C = 1/4 time, 12 months, graduate assistant
D = full time, 9 months, graduate assistant
3/4 D = 3/4 time, 9 months, graduate assistant
1/2 D = 1/2 time, 9 months, graduate assistant
1/4 D = 1/4 time, 9 months, graduate assistant

After the departmental executive officer listed the employment base of each individual staff member, the staff members' employment base was distributed over six major functional areas -- undergraduate teaching/advising, graduate teaching, research, in-service/extension, administration, and other. Actual employment records were used or the departmental executive officer allocated the time to each respective function based upon his/her judgment of how that particular staff member was spending his/her time. These data were then aggregated by university and converted to full-time equivalents where a full-time equivalent is defined as an A-base employment (12 months, full time). The data for each university are reported in Table 4.5. They show the total number of full-time equivalents by major functional area and the percentage of total for each area. The mean per department is also shown in Table 4.5. Figure 4.6 shows the percentage distribution of faculty/staff time in full-time equivalents for the study departments. For the 1978-1979 year, there were a total of 50.6 full-time equivalents employed in the eight study departments. The departments ranged from a low of 3.0 FTE's to a high of 11.0 FTE's with a mean of 6.32 FTE's per department.

The undergraduate teaching/advising program, as a major functional area within each department, accounted for 18.8% to 69% of the total staff resources. For all departments, it is slightly more than 36% of the total staff time used. As shown in Table 4.5, the undergraduate teaching/advising program required 18.275 FTE's. The research program followed the undergraduate teaching/advising program in terms of staff time utilization. Nearly 27% of the total time reported by the

Table 4.5. Distribution of faculty and staff time expressed in full-time equivalent (FTE) by major function for the study departments, 1978-1979

Land grant university	Total FTE's	Undergraduate teaching No.	Undergraduate teaching Pct. total	Graduate teaching No.	Graduate teaching Pct. total	Research No.	Research Pct. total	In-service extension No.	In-service extension Pct. total	Administration No.	Administration Pct. total	Other No.	Other Pct. total
Iowa	11.000	3.250	29.5	1.65	15.0	2.75	25.0	1.35	12.4	.50	4.5	1.50	13.6
Illinois	5.875	1.725	29.4	1.225	20.9	2.675	45.5			.25	4.2		
Minnesota	8.00	3.25	40.6	1.40	17.5	1.20	15.0	.65	8.1	1.20	15.0	.30	3.8
Missouri	8.375	1.575	18.8	1.000	11.9	3.600	43.0	1.35	16.1	.60	7.2	.25	3.0
Nebraska	6.875	3.025	44.0	.740	10.7	1.620	23.6	1.09	15.9	.40	5.8		
North Dakota	3.50	1.57	44.9	.48	13.7	.75	21.4	.19	5.4	.50	14.3	.01	.3
Purdue	4.00	1.80	45.0	.90	22.5	.75	18.8	.30	7.5	.25	6.2		
South Dakota	3.00	2.08	69.3	.27	9.0	.15	5.0	.20	6.7	.15	5.0	.15	5.0
Totals	50.625	18.275		7.665		13.495		5.13		3.85		2.21	
Pct. total			36.1		15.1		26.7		10.1		7.6		4.4
Mean/ department	6.32	2.28		.96		1.69		.64		.48		.28	

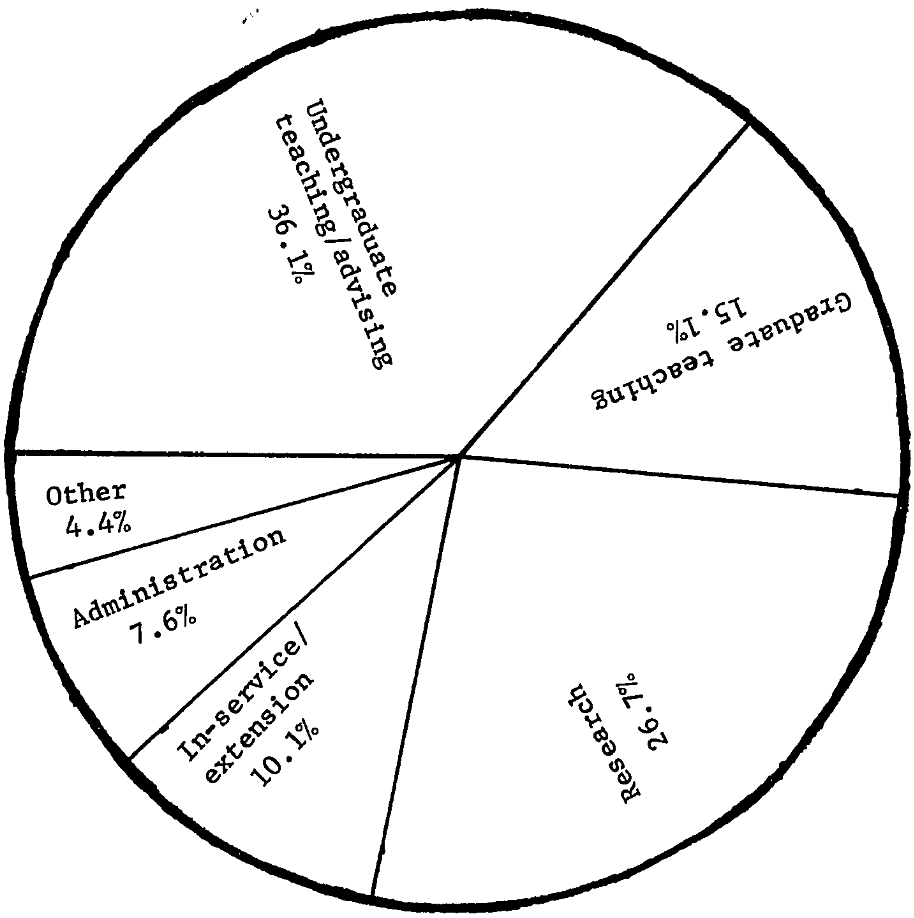

Figure 4.6. Percentage distribution of faculty and staff time for the study departments, 1978-1979

departmental executive officers is used for this program. This amounts to 13.495 FTE's. For the individual departments, the amount of staff time used in research varied from .15 FTE to 3.60 FTE's. Less staff time is used in the graduate teaching, in-service, and other functions.

From the data in Table 4.5, it can be noted that there is a large variation in the number of FTE's used in the graduate teaching, research, and in-service/extension education functions of the program. Each of these varied by more than one full-time equivalent. For example, in the graduate teaching program, the lowest is .27 FTE's, while the highest is 1.65 FTE's. Similarly, for research the number of FTE's varied from .15 to 3.6.

Each departmental executive officer then allocated the faculty/staff time by major program area with a function. Program areas are identified from university catalogs, observation, and conferences with various agricultural education staff. The program categories for undergraduate and graduate teaching tend to follow course descriptions found in university catalogs. Research program areas were delineated to parallel those identified for the graduate teaching program. All of the program areas within each functional area are listed below:

Undergraduate teaching/advising

a. Undergraduate advising
b. Introductory courses
c. Occupational experience
d. FFA programs
e. Teacher preparation and/or methods
f. Extension
g. Other

Graduate teaching/advising

a. Curriculum and curriculum development
b. Teacher education and/or methods
c. Philosophy and/or policy
d. Evaluation
e. Leadership, guidance, occupational experience
f. Administration
g. Extension
h. Other

Research

a. Curriculum and curriculum development
b. Teacher education and/or methods
c. Philosophy and/or policy
d. Evaluation
e. Leadership, guidance
f. Administration
g. Extension
h. Other

No sub-program designations were made for administration, extension, and the other category. For each individual staff member, an allocation is to the sub-program within each major function. For example, if a staff member is using 100% of his total time in undergraduate teaching/advising, then that staff member's time is allocated in percentage terms among the seven program areas listed for the undergraduate program. These data were then aggregated by department to show the number of FTE's within each program area within a major functional area. These data are presented in Tables 4.6, 4.7, and 4.8, and Figures 4.7, 4.8, and 4.9.

Table 4.6 shows the distribution of faculty and staff time in full-time equivalents used in the undergraduate teaching/advising program, and Table 4.7 shows the same distribution in full-time equivalents for the graduate teaching program. Finally, Table 4.8 shows the distribution by research.

Table 4.6. Distribution of faculty and staff time in full-time equivalent (FTE) used in undergraduate teaching and advising by specialized areas of instruction for the study departments, 1978-1979

Land grant university	Under-graduate advising	Introductory courses	Occupational experience	FFA programs	Teacher preparation and/or methods	Extension	Other	Totals (FTE)
Iowa	1.20	.35	.25	.25	1.00	.20		3.25
Illinois	.35	.50			.875			1.725
Minnesota	.65	.82	.15	.15	1.48			3.25
Missouri	.395	.075	.13	.03	.8175	.115	.0125	1.575
Nebraska	.75	.65		.40	1.225			3.025
North Dakota	.47	.08	.10	.23	.50		.19	1.570
Purdue	.38	.10	.17	.17	.81		.17	1.80
South Dakota	.52	.27	.10	.09	1.00		.10	2.08
Totals	4.712	2.845	.90	1.32	7.7075	.315	.4725	18.275
Pct. total	25.8%	15.6%	4.9%	7.2%	42.2%	1.7%	2.6%	

Table 4.7. Distribution of faculty and staff time in full-time equivalent (FTE) used in graduate teaching program for the study departments, 1978-1979

Land grant university	Curriculum	Teacher education and/or methods	Philosophy and/or policy	Evaluation	Leadership and/or guidance	Administration	Extension	Other	Totals (FTE)
Iowa	.10	.90	.20	.20	.15	.10			1.65
Illinois	.25	.62	.13					.225	1.225
Minnesota	.30	.20	.25	.15	.15	.35			1.40
Missouri	.165	.265	.035	.025	.025	.075	.02	.39[a]	1.00
Nebraska		.25	.25			.15		.09	.74
North Dakota	.20	.10	.07		.02			.09	.48
Purdue	.10	.55		.25					.90
South Dakota	.04	.13	.02	.03	.04	.01			.27
Totals	1.155	3.015	.955	.655	.385	.685	.02	.795	7.665
Pct. total	15.1%	39.3%	12.5%	8.5%	5.0%	8.9%	.3%	10.4%	

[a]Includes graduate advising time.

Table 4.8. Distribution of faculty and staff time in full-time equivalent (FTE) used in research by specialized area for the study departments, 1978-1979

Land grant university	Curriculum	Teacher education and/or methods	Philosophy and/or policy	Evaluation	Leadership and/or guidance	Administration	Extension	Other	Totals (FTE)
Iowa	.75	.25		.75	.25			.75	2.75
Illinois	.10	.3875		.5875				1.60	2.675
Minnesota	.45	.30	.20	.10	.10	.05			1.20
Missouri	3.2375	.10		.20	.005	.05	.0075		3.60
Nebraska	.87	.75							1.62
North Dakota	.15							.60	.75
Purdue	.55		.10	.10					.75
South Dakota	.13			.02					.15
Totals	6.2375	1.7875	.30	1.7375	.375	.10	.0075	2.95	13.495
Pct. total	46.2%	13.2%	2.2%	12.9%	2.8%	.7%	.1%	21.9%	

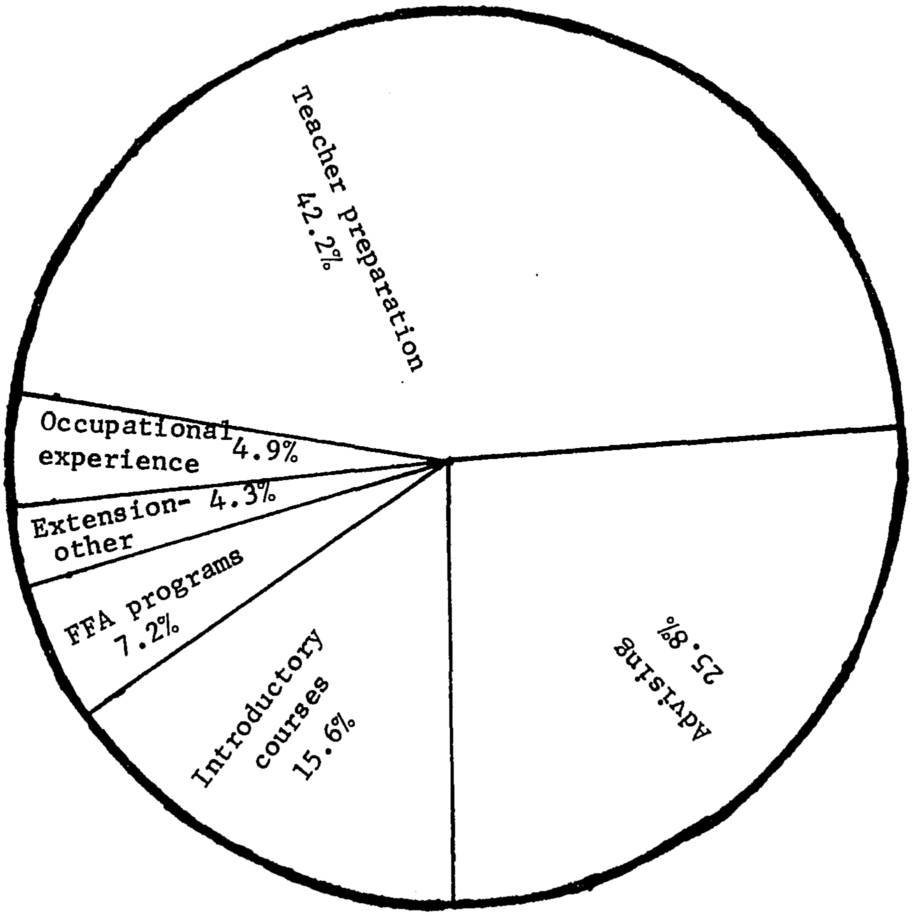

Figure 4.7. Percentage distribution of faculty/staff time in the undergraduate teaching/advising program of the study departments, 1978-1979

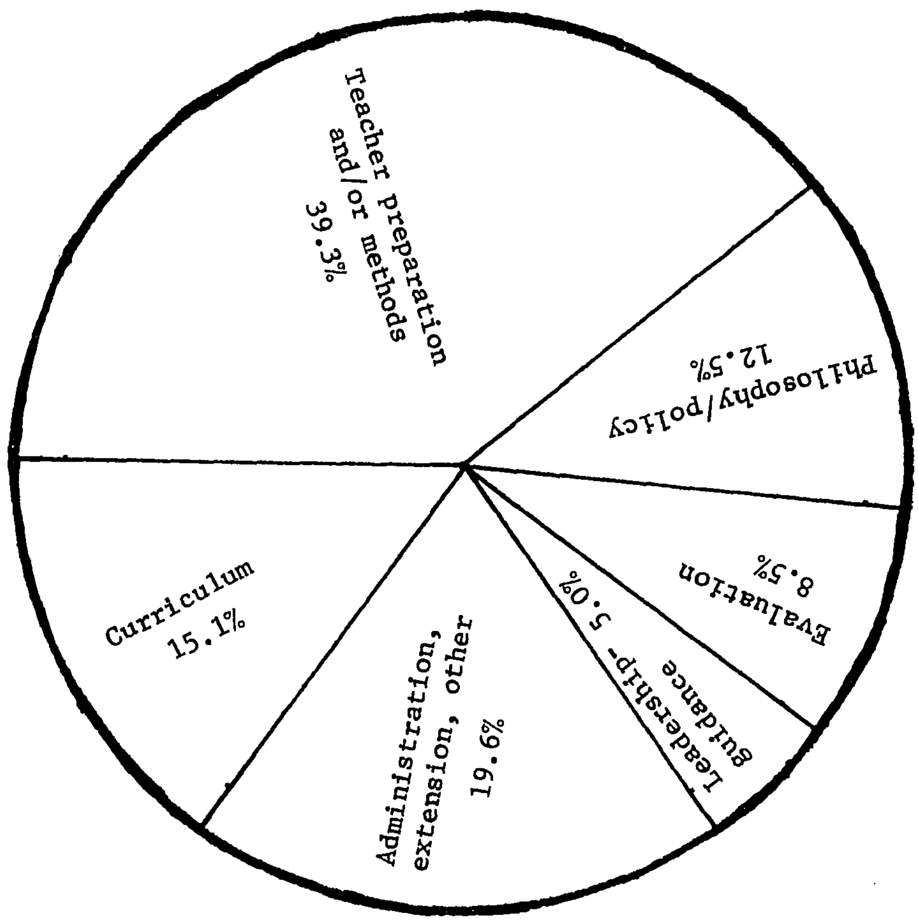

Figure 4.8. Percentage distribution of faculty/staff time in the graduate teaching/advising program of the study departments, 1978-1979

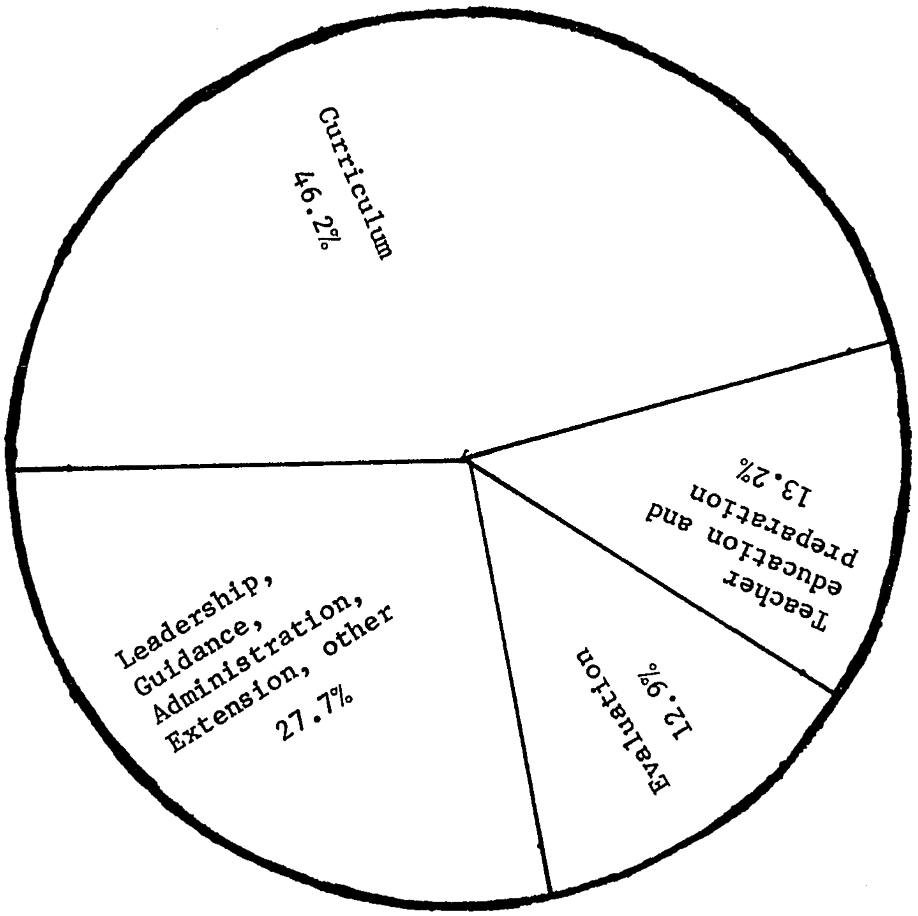

Figure 4.9. Percentage distribution of faculty/staff time in the research program of the study departments, 1978-1979

For the undergraduate teaching program, the major uses of staff time are undergraduate advising and teacher preparation and/or methods. These two accounted for over two-thirds of the total staff time. Lesser amounts of time are used for occupational experience, extension activities, and other activities of the department.

From Tables 4.7 and 4.8, it is apparent that teacher evaluation and/or methods, curriculum, and program evaluation are major topic areas for graduate teaching and research. For the graduate teaching program, almost two-thirds of the total full-time equivalents are used in these areas. Similarly, for the research function, over 70% of the total time used in research is for these three areas. Teacher evaluation and/or methods required almost one-half of the total time in graduate teaching. This was by far the largest time utilization and also had a fairly wide variability as reported by departments ranging from a low of .10 FTE's to a high of .9 FTE's. Curriculum materials and curriculum development is a major research area as denoted by almost 50% of the total research being used in this area. It, too, had an extremely wide variation by department, ranging from a low of .10 FTE's to a high of 3.2375 FTE's.

It should be noted that teacher evaluation and/or methods for the graduate teaching and research program includes courses taught in methods of teaching, courses taught in teacher preparation at the graduate level, and courses taught to aid teachers in improving their skills in the classroom. Similarly, research in this area would include such items as measuring teacher performance, research on methods of teaching, and the like. Research and graduate teaching for curriculum would include such items as developing curriculum materials, testing curriculum materials in the classroom, and identifying factors that influence the selection of curriculum.

Faculty and staff salaries

Each departmental executive officer listed faculty/staff salaries including fringe benefits contributed by the university. Faculty/staff members are coded by their Social Security number to retain their anonymity in the study. All salaries and fringe benefits were listed regardless of their source. A faculty/staff member's total salary was then distributed among the six major functional areas according to the total time spent within each function. For example, if a staff member is employed on a 50% research-50% teaching position, one-half of his total salary plus fringe benefits was allocated to undergraduate or graduate teaching program and one-half to research. The data were aggregated by department within each functional area and are reported in Table 4.9.

In Table 4.9, total faculty/staff salaries varied from a low of \$65,731 to a high of \$233,855. The total salaries paid to staff for all eight departments is more than \$1 million. Salaries paid to faculty/staff in the undergraduate teaching program ranged from \$35,910 to \$105,440. The range in graduate teaching and research salaries is similar to the undergraduate program with graduate program salaries ranging from a low of \$5,882 to a high of \$44,600. Research program salaries varied from \$3,287 to \$49,225. Some departments showed no salaries paid for in-service/extension and other activities, because

Table 4.9. Distribution of faculty and staff salaries by functional area for study departments, 1978-1979

Land grant university	Total salaries	Undergraduate teaching	Graduate teaching	Research	In-service/ extension	Administration	Other
Iowa	223,855	68,772	44,600	40,287	23,716	16,850	29,630
Illinois	131,750	39,975	33,800	49,225	--	8,750	--
Minnesota	256,782	105,440	43,189	31,678	23,795	48,885	3,792
Missouri	155,084	35,910	26,916	35,527	34,026	16,142	6,563
Nebraska	206,548	80,237	24,119	46,682	39,830	15,680	--
North Dakota	85,250	39,027	12,422	11,119	4,836	17,648	198
Purdue	84,750	36,412	19,387	16,532	6,181	6,238	--
South Dakota	65,731	45,407	5,882	3,287	4,187	3,682	3,286
Totals	1,209,750	451,180	210,315	234,337	136,571	133,875	43,469
Pct. total		37.3%	17.4%	19.4%	11.2%	11.1%	3.6%

no time was reported for these activities. Program administration salary costs varied from $3,682 to $48,885.

The percentage distribution of faculty/staff salaries by functional area is shown in Figure 4.10. As expected, the largest use of salary funds is for the undergraduate teaching/advising program, accounting for more than 37% of the total. The research and graduate functions ranked second and third, respectively, with research salaries amounting to 19.4% of the total and graduate teaching accounting for 17.4% of the total. The in-service/extension function ranked fifth with 11.2% of the salaries used. Salaries for program administration were 11.9% of the total. Administration salaries are largely those paid to the departmental executive officer within each department. Program administration costs represent that portion of the departmental executive officer's salary directly charged to administering the program.

If the undergraduate teaching and graduate teaching salaries are combined, then 53.8% of all salaries is used to support the teaching function of the program. Likewise, if the graduate teaching and research programs are combined, they represent 38.8% of the total, which is only slightly larger than the undergraduate teaching program. From these data, it is apparent that the undergraduate teaching program is a high priority function within each department with the research and in-service/extension function being of lesser importance.

Comparison of Faculty/Staff Time Versus Salary

Figure 4.11 shows the comparison of faculty/staff time to faculty/staff salaries by major functional areas. As shown in Figure 4.11,

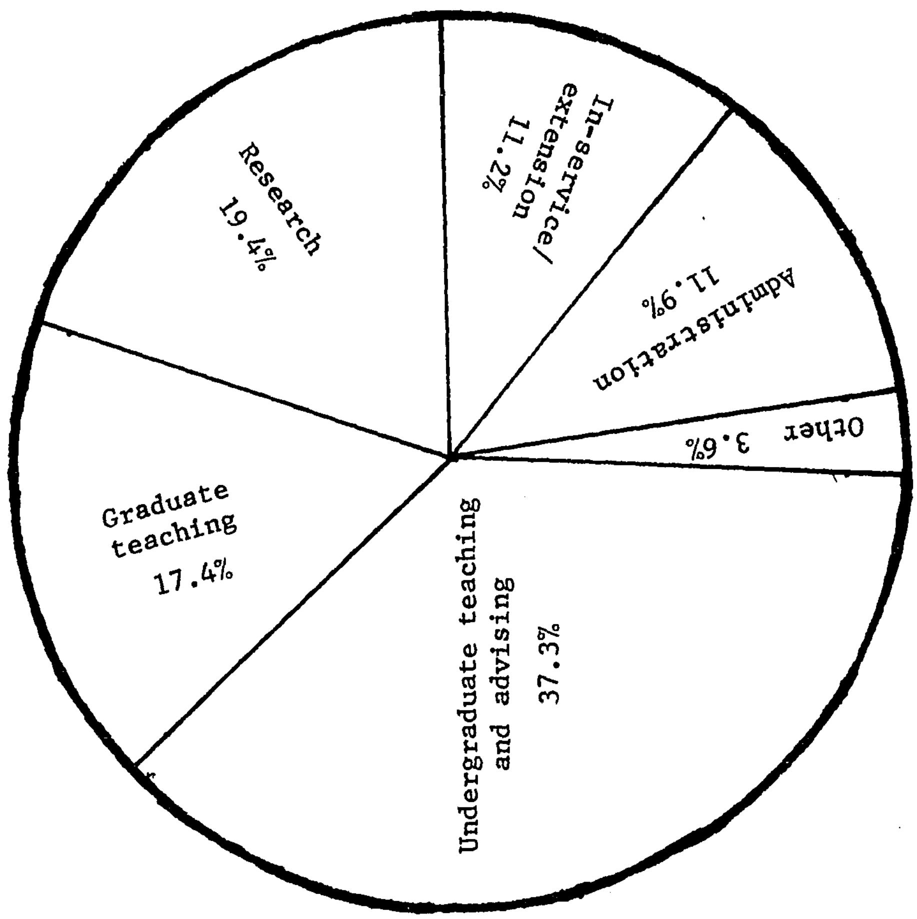

Figure 4.10. Percentage distribution of faculty/staff salary by functional area for study departments, 1978-1979

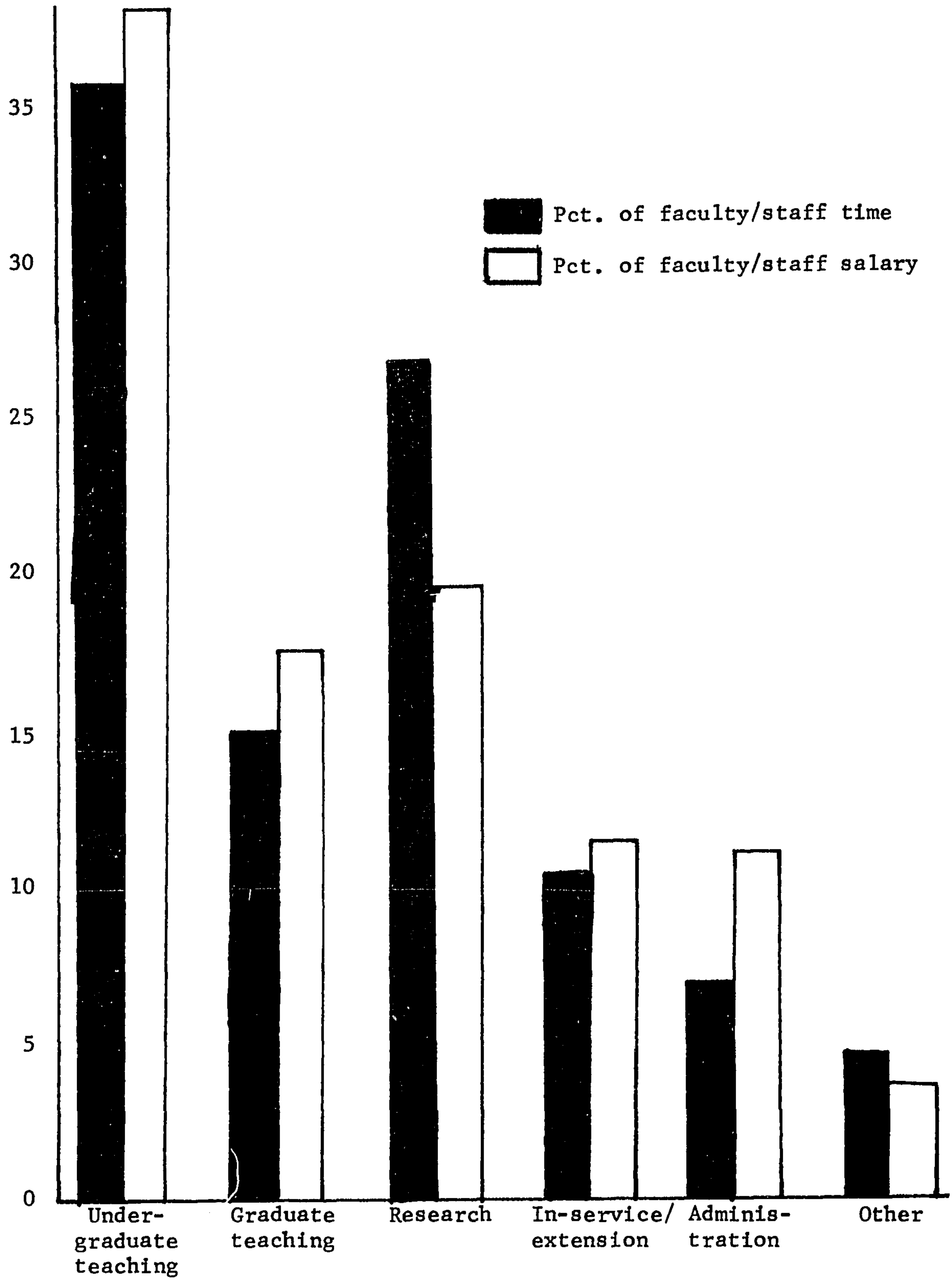

Figure 4.11. Comparison of faculty/staff time to salary by major functional area for study departments, 1978-1979

the percentage of faculty/staff time is fairly comparable to the salaries paid for the undergraduate teaching program and the in-service/extension program. However, a larger disparity is noted for the graduate teaching and research programs. For the graduate teaching program, the percentage of salaries paid exceeds the percentage of time spent in this program. That is, slightly more than 15% of the total staff time is used in the graduate teaching program, while more than 17% of the salaries is used to support the staff in this area. The opposite is true for the research program, where over 25% of the total staff time is used in research, but less than 20% of the salaries is used to support this program.

There is a plausible explanation for both of these phenomena. First, many graduate courses are taught by tenured professors who are higher paid. Likewise, the salaries paid to research staff include professional staff and graduate assistants. Graduate assistants are paid less and spend nearly all of their time in research. Hence, program costs relative to time do not follow the same proportional trend.

Input/Output Ratios and Their Measurement

In previous sections, program output data are presented on semester credits, semester credit contact hours, and numbers of graduates. Inputs for the study departments have been measured in terms of faculty/staff time and salaries by functional area. This section will combine some of the output and input data together to look at input/output ratios for the study departments.

Comparison of input/output ratios to the standards project

Standards for Quality Vocation Programs in Agricultural/Agribusiness Education project (4) developed many standards regarding student enrollment, advising, instructional program, graduate programs, in-service education, staffing, and research for teacher education programs in land grant universities. Specific standards are formulated for staffing, funding, advising, and related items, and these standards can be compared to the data collected from the study departments. In most cases, the mean per department will be compared to the standard developed.

Professional staffing Several standards are recommended for professional staffing. These relate to education, employment, and job responsibilities of the staff. For the faculty/staff, it is suggested that 75% of the staff have earned a doctorate degree and 100% of the staff have earned a master's degree. As shown in Table 4.2, five of the eight departments met these standards. At the same time, the number of departments having more than 75% of the faculty/staff with a doctorate degree was achieved by only three of the eight departments. On the average, nearly two-thirds of the staff had completed a Ph.D. degree.

Another standard specified that all members of the faculty have a 12-month appointment. Again, this standard was not met by all the study departments. However, if only professorial staff are included in the determination of this standard, most departments would meet the standard.

Teacher preparation and supervision The standards project also indicates that a minimum of two full-time equivalent faculty be employed to help students learn needed competencies in agricultural education, to advise students, and to supervise intern experiences. Measuring this standard using the collected data is more difficult, but assuming that the number of FTE's used in undergraduate advising and teacher preparation and/or methods at the undergraduate level are combined to meet this standard, then most departments would not have met this standard. In fact, only one department had more than two full-time equivalents in undergraduate advising and teacher preparation and/or methods. Most departments had at least one full-time equivalent in this area.

Research Standards relating to research suggest that 10% of the total staff time should be devoted to research. As shown in Table 4.5, the total amount of research time averaged about 27%. Only one department did not meet this standard.

Advising The departments were also compared against the standards project for the ratio of faculty to advisees in the undergraduate and graduate program. From the standards project, the maximum number of advisees per faculty member is recommended to be 25 for undergraduate students and 10 for graduate students. That is, the standards project specified 25 advisees per faculty member for the undergraduate program and 10 advisees per faculty member for the graduate program. Table 4.10 shows the results for the study departments for the 1978-1979 year. The number of undergraduate and graduate advisees was calculated by taking the average enrollment for the

Table 4.10. Undergraduate advisees per staff member and graduate advisees per staff member for the study departments, 1978-1979

Land grant university	Undergraduate advisees per staff member[a]	Graduate advisees per staff member[b]
Iowa	17.87	11.0
Illinois	12.5	19.5
Minnesota	29.4	12.87
Missouri	28.5	82.0
Nebraska	25.2	10.0
North Dakota	31.33	7.0
Purdue	28.25	13.75
South Dakota	40.33	5.66

[a]Calculated as average enrollment for academic year divided by number of staff with responsibility in undergraduate advising.

[b]Calculated as average enrollment for academic year divided by number of staff with responsibility in graduate teaching/advising.

academic year. That is, the number of students at the beginning of the academic year was added to the number of students at the end of the year and divided by two to give the average number of students for the year. This was then divided by the number of staff members with responsibility in advising. As noted in Table 4.10, three departments met the standard, while the remainder exceeded the standards. Several of those failing to meet the standards did so by a very narrow margin. For the graduate program, three departments met the standards, and the rest did not. One department exceeded the standards by a very wide margin. Many of these advisees represent off-campus graduate students enrolled in a master's degree program.

Faculty/staff salary cost per FTE

An important cost ratio used to compare departments and functions within departments is the faculty/staff salary cost per full-time equivalent. Faculty salary cost per full-time equivalent is calculated by taking the total faculty/staff salaries for a functional area and dividing it by the number of full-time equivalents employed in that function. These data are presented in Table 4.11. For the eight study departments, the faculty/staff salary cost per FTE for all functions is $23,884, with a range from $18,517 to $30,043. Only one department had a cost ratio less than $20,000. One department reported a cost ratio between $20,000 and $21,000, while three departments fell between $21,000 and $24,000. The remaining departments exceeded $24,000.

The data are also reported by major functional area; that is, undergraduate teaching, graduate teaching, research, in-service/ extension, administration, and other.

The range in faculty/staff salary cost per FTE by function is from a low of $19,364 for research to a high of $32,542. If the program administration costs per FTE are excluded, the range narrows from a low of $19,364 to a high of $26,773. This represents a difference of 38.3%.

Table 4.11. Faculty salary cost per full-time equivalent (FTE) by major function for the study departments, 1978-1979

Land grant university	Undergraduate teaching	Graduate teaching	Research	In-service/ extension	Administration	Other	All functions
Iowa	21,161	27,030	14,650	17,567	33,700	19,753	$20,530
Illinois	23,174	27,592	18,402		35,000		22,426
Minnesota	32,443	30,849	26,398	36,608	40,738	12,640	32,098
Missouri	22,800	26,916	9,868	25,204	26,903	26,252	18,517
Nebraska	26,525	32,593	28,816	36,541	39,200		30,043
North Dakota	24,858	25,879	14,825	25,453	35,296	19,800	24,357
Purdue	20,228	21,541	22,043	20,603	24,952		21,188
South Dakota	21,830	21,785	21,913	20,935	24,547	21,907	21,910
Departmental mean	24,127	26,773	19,364	26,130[a]	32,542	20,070[b]	$23,884

[a]Sample size equals 7 departments.

[b]Sample size equals 5 departments.

The salary cost per FTE for the administration program is the highest, because generally a highly tenured faculty member serves as departmental executive officer.

Lower salary costs per FTE are observed for the research program, while higher cost ratios are noted for the graduate program. The higher cost ratio for the graduate program is due to higher paid faculty with tenure doing most of the teaching, while the lower costs in research are due to graduate research assistants and non-tenured faculty conducting most of the research programs.

The data from Table 4.11 are plotted on a bar graph as shown in Figure 4.12.

Semester credits per full-time equivalent

Comparisons were also made between the number of semester credits per full-time equivalent for each department between the undergraduate and graduate program, as shown in Table 4.12. The number of semester credits per full-time equivalent is an indication of the teaching load for the faculty within the department. The number of undergraduate semester credits per FTE varied from 15.5 to 35.7 with a mean of 19.6 credits per FTE. The range in undergraduate credits per FTE represents a 230% variation; however, most departments clustered around 14 to 17 credits per FTE.

A similar variation is noted for graduate semester credits per FTE, with the number of credits per FTE varying from 25.9 to 62.5. Most departments were clustered around 35 to 45 semester credits per FTE. The mean graduate credits per FTE is 41.4 credits.

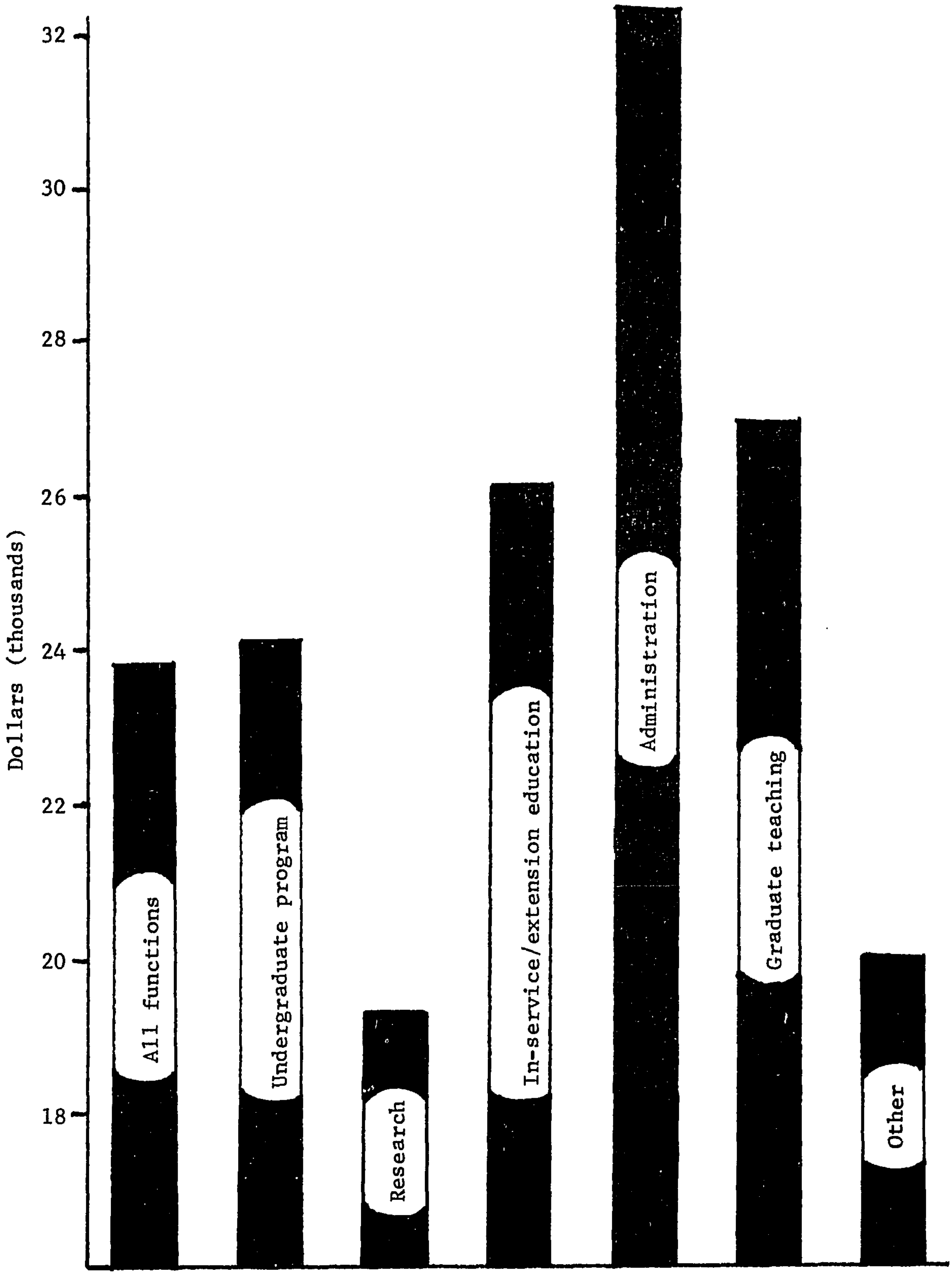

Figure 4.12. Faculty/staff salary cost per full-time equivalent by major function area for study departments, 1978-1979

Table 4.12. Semester credits per full-time equivalent, salary cost per semester credit, and salary cost per semester credit hour for the study departments, 1978-1979

Land grant university	Semester credits per FTE			Salary cost per semester credit		Salary cost per semester credit hour	
	Undergraduate	Graduate	Total	Undergraduate	Graduate	Undergraduate	Graduate
Iowa	21.3	27.5	48.8	$ 992.38	$984.55	$60.79	$ 53.73
Illinois	13.9	35.9	49.8	1,665.63	768.18	94.06	68.15
Minnesota	13.9	33.6	47.5	2,343.11	918.91	95.76	69.89
Missouri	17.2	43.0	60.2	677.55	625.95	39.46	68.83
Nebraska	17.5	40.5	58.0	1,513.91	803.96	63.98	101.77
North Dakota	35.7	62.5	98.2	696.91	414.07	44.49	115.02
Purdue	15.5	54.4	69.9	1,300.43	395.65	110.00	54.61
South Dakota	15.9	25.9	41.8	1,375.97	840.29	84.87	66.84
Mean	19.6	41.4	61.0	$1,174.68	$690.38	$ 71.09	$ 75.56

Faculty/staff salary cost per semester credit

Faculty/staff salary costs per semester credit are calculated by taking total faculty/staff salary costs including fringe benefits and dividing by the number of semester credits. However, the salary costs are not the total costs for providing an education to the undergraduate or graduate student. Other costs including salaries for support staff, building costs, and general operating costs are not included in this analysis. Hence, these figures should not be interpreted as being the total cost of providing the education per credit and then equated to some figure denoting the revenue received per credit.

For the salary cost per credit, the average for the undergraduate program is $1,174.68 compared to $690.38 for the graduate program. More classroom teaching occurs in the undergraduate program requiring more staff salaries; hence, the cost per credit tends to increase relative to the graduate program where fewer classes are offered and more time is devoted to individual study and research credits.

Salary cost per semester credit hour

This input/output measure is calculated by taking the faculty/staff salaries allocated to this function and dividing by the total number of semester credit hours where the number of semester credit hours is the number of semester credits in a course times the number of students completing the course.

As with the salary cost per credit, the measure does not reflect the total cost to a university but is an indication only of salary costs. From Table 4.12, it is apparent that there is little difference in the costs per credit hour for the undergraduate and graduate program.

Effect of Size on Input/Output Ratios

Thus far, all statistics gathered from the study departments have been reported as a mean per department and study totals. This section will analyze selected data by size groups to determine if size has any impact upon an input/output ratio. The eight study departments were divided into two samples of approximate equal size based upon undergraduate enrollment. The size groupings designated were departments with less than 120 undergraduate students and departments greater than 120 students. The undergraduate enrollment was determined as the average of the enrollment at the beginning and the ending of the year. Those departments in the larger size group contained four departments, including Iowa, Minnesota, Nebraska, and South Dakota. The smaller departments contained four departments including Illinois, Missouri, North Dakota, and Purdue.

The statistical test used to test the difference between the large size departments versus the small size departments is the paired "t test" to measure the difference between two sample means. In this situation, it is assumed that the sample is taken from two normally distributed populations with a common variable or unequal variance. A test can be made to determine whether the samples have a common variance.

The null and alternate hypotheses are shown below. The null hypothesis states that the population means are equal, while the alternate hypothesis states that the two population means are not equal.

$$Ho: \; u_1 = u_2$$

$$H_A: \; u_1 \neq u_2.$$

The two populations are sampled and the means and variances are computed based upon the sample size of each. The test statistic is calculated according to the following equation.

$$t_{\bar{d}} = \frac{(\bar{X}_1 - \bar{X}_2)}{S_{\bar{d}}} \quad \text{where} \quad S_{\bar{d}} = \left[\frac{S^2}{n_1} + \frac{S^2}{n_2}\right]^{.5} .$$

The α level is selected for $(n_1 + n_2 - 2)$ degrees of freedom, and the test statistic is compared to the "t" value. If the test statistic > "t" value, then the null hypothesis is rejected, and there is a significant difference in the sample means.

Several input/output ratios were analyzed by size groupings. By broad categories, these measures dealt with class size, salary costs per FTE, time allocation by function, semester credits per FTE, and cost relationships between credits and salaries. The means for each size group and the test statistic value are shown in Table 4.13.

Four levels of significance were chosen -- probability values of .025, .05, .10, and .20. For this small sample size, it was necessary to increase the probability value in order to find some variables significant.

Only five factors were significantly different in comparing the large departments to the small departments, as shown in Table 4.13. Semester credits per FTE in graduate programs, which is an indication

Table 4.13. Statistical comparison of means between small and large study departments using various input/output ratios

Variable	Mean: < 120 students	Mean: > 120 students	"t value"
Average class size	13.2	17.9	1.10
Salary cost per FTE			
Undergraduate program	$22,790	$29,600	1.03
Graduate program	23,184	28,463	1.63*
Research	11,684	24,057	2.09**
In-service/extension	17,815	25,360	1.03
All functions	21,622	27,272	1.43
Percent time by function			
Undergraduate program	34.3%	45.9%	1.08
Graduate program	17.3	13.1	1.29
Research	32.2	17.2	1.79*
In-service/extension	7.3	10.8	.89
Semester credits per FTE			
Undergraduate program	20.57	17.15	.64
Graduate program	48.95	31.88	2.52**
Salary cost per semester credit			
Undergraduate program	$ 1,085.13	$ 1,556.34	1.26
Graduate program	550.96	886.92	3.43***
Salary cost per semester credit contact hour			
Undergraduate program	$ 72.00	$ 76.35	.22
Graduate program	76.65	73.06	.22
Students per FTE			
Undergraduate program	41.3	47.3	.48
Graduate program	144.6	57.6	.98

*Significant at $p < .20$.

**Significant at $p < .10$.

***Significant at $p < .025$.

of graduate teaching load, is significant at $p < .10$. Likewise, the salary cost per semester credit in the graduate program is significantly different. Significant differences in other variables were observed for salary costs per FTE for graduates and research programs and the percentage of time devoted to research.

No significant differences were noted in all of the other major factors including average class size, and salary costs per FTE for the undergraduate and in-service programs. This would indicate that size generally does not affect class size, teaching loads at the undergraduate level, and time allocation for graduate and undergraduate functions. No economies of size occur as departments tend to grow in size.

Respondents' Perception of Resource Management and Alternatives for Resource Allocation

The departmental executive officers were polled to indicate how they perceived their departmental output and how they would alter their departmental resource mix under different situations.

Based upon knowledge and observation of their respective department, the departmental executive officers were asked to indicate the proportion of their department's use of resources from each functional area. Table 4.14 shows the results.

As Table 4.14 shows, nearly one-half of the perceived inputs are devoted to the undergraduate teaching and advising program. Graduate teaching and advising is second with slightly less than one-fourth of the inputs used for these functions.

Table 4.14. Departmental resources used as perceived by the departmental executive officer for the study departments, 1978-1979

Function	Percentage of total
Undergraduate teaching/advising	48.8%
Graduate teaching/advising	23.1
Research	14.4
In-service and extension	13.7

The perception of the departmental executive officers is compared to the actual data. While the actual data contain resources used for the administrative and other related functions, this does not make this comparison totally invalid.

As shown in previous tables and figures, over 35% of the total faculty/staff time is devoted to the undergraduate teaching/advising. About 37% of the salaries was used to support this function. Both of these percentages are less than the perceptions of the departmental executive officers.

A similar situation exists with the graduate teaching/advising program. The departmental executive officers perceived that more resources were being used to support the graduate program than shown by the actual data. The respondents perceived that 23% of the resources was used to support the program, while the data analysis in Figure 4.12 show that less than 20% of the FTE and salaries was used in this program area.

The actual mix of resources used in the research program exceeded the perception of the departmental executive officers. This would tend to indicate that more research is being conducted than perceived by the departmental heads.

For the in-service and extension functions, the perception of resource use is comparable to the actual time and salaries reported.

Since program emphasis may change as new demands are placed upon an agricultural education department, the departmental executive officers were asked how they would alter their resources within the department if greater productivity is desired. Specifically, would the resource mix in each function increase, decrease, or remain unchanged? Table 4.15 reveals the proportional mix after the resource reallocation. This analysis assumes that no additional resources are available.

Table 4.15. Departmental resource allocation as perceived by the departmental executive officer after resource reallocation when no additional resources are available

Function	Percentage of total
Undergraduate teaching/advising	48.8%
Graduate teaching/advising	21.0
Research	17.5
In-service and extension	12.7

In this situation, the resources devoted to the undergraduate program remain unchanged. More resources would be devoted to research and less to graduate and in-service programs. This indicates a desire to make the research function a more visible function and a desire to increase its emphasis relative to the other functional areas.

Even more emphasis is placed upon research when unlimited resources are available to each departmental executive officer. The last hypothetical situation allowed each department head to allocate his resources among the functional areas if staff resources are unlimited. In this situation, the amount of resources devoted to research increases at the expense of undergraduate teaching. The results are shown in Table 4.16.

Table 4.16. Resource mix when unlimited resources are available as perceived by the departmental executive officers

Function	Percentage of total
Undergraduate teaching/advising	43.8%
Graduate teaching/advising	22.5
Research	20.0
In-service and extension	13.8

Compared to the present perception of the department heads, the amount of resources for the undergraduate program would decrease by 5%, while the research effort would expand by about the same percentage.

To measure how the department heads felt about resources used in their programs, ten questions were prepared asking them to respond on a rank ordering from strongly disagree to strongly agree. These questions are designed to illicit responses about program direction, staff allocation, and other issues of concern to resource managers as they plan and direct programs. Table 4.17 lists the response statement, the distribution of responses, and the mean score.

Table 4.17. Mean scores and distribution of responses on research management and program direction

	Number responses					
	Strongly disagree 1	2	3	4	Strongly agree 5	Mean score
1. Departmental resources should be allocated so that the greatest concern is to maximize total output from the department.		1		4	3	4.125
2. Department resources should be allocated so that the greatest concern is for the staff and/or student.			2	3	3	4.125
3. Joint appointments (across two or more colleges) contribute more to the productivity of the department than appointments in a single college.	5	1	2			1.625
4. Split appointments (teaching/research; teaching/extension) contribute more to the overall productivity of the department than a single appointment (e.g., teaching only).			5	1	2	3.62
5. Staff members on split appointments (teaching/research, etc.) should remain on those appointments for the entire academic year rather than switching back and forth each quarter or semester; i.e., teaching one semester followed by all research next semester.		1	2	1	4	4.00
6. Departmental resources should be directed towards more undergraduate ag. ed. courses that are "service courses" for students majoring in other curricula.	4	3			1	1.875

Table 4.17. (Continued)

	Number responses: Strongly disagree 1	2	3	4	Strongly agree 5	Mean score
7. Departmental resources should be directed towards more ag. ed. graduate courses that are "service courses" for students majoring in other curricula.		2	4	1	1	3.125
8. Staff members in agricultural education can be most effective and provide a greater contribution to the total educational system if they have a specialty in technical agriculture in addition to their expertise in education.		3	3	1	1	3.00
9. Resources used for in-service education of secondary and post-secondary teachers could be more effectively used if reallocated to in-service and professional training of university faculty members in the department.		4	3	1		2.62
10. Resources used for departmental research should be increased to improve the quantity and quality of "interdisciplinary" research with other technical agricultural departments.			5	1	2	3.62

The department heads are in almost total agreement on several issues but show nearly total disagreement on several other issues. Most respondents feel that departmental resources should be allocated so that the greatest concern is to maximize total output from the department and still show concern for the staff member and/or student. Many times these two goals may be in direct conflict with each other, but since the two issues were treated independently in the survey, the responses were comparable even though many issues facing a department may require sacrifices by the student or staff to achieve greater productivity from the department.

Even though many faculty/staff hold joint appointments between two colleges (usually agriculture and education), the majority of the department heads felt that faculty appointments within a single college contribute more to the total program. For a staff member in agricultural education holding a joint appointment between the colleges of agriculture and education, the technical expertise of both colleges could be utilized in the total program; hence, the overall productivity of the program should increase. Most department heads did not share the same view.

There is a strong concern about retaining the identity of the agricultural education program and keeping it for the preparation of teachers as evidenced by the response in question six. One possibility to expand program efforts is to make agricultural education courses more attractive to undergraduate students in other curricula. This increases the visibility of the department, broadens the educational perspective of the student, and makes the student more aware of career opportunities in agricultural education. Only one department head shared this view, while the others took an opposite viewpoint that undergraduate courses should be primarily for training and preparation of teachers.

The respondents were somewhat neutral on the same issue as it relates to graduate courses. Most were undecided about this particular issue.

The departmental executive officers are generally in favor of interdisciplinary research with other technical agricultural departments. Research projects between these departments would enhance the quality and quantity of research in the departments involved. The technical expertise of all disciplines involved can be focused upon the research problem. None of the department heads disagreed with this issue.

This chapter has attempted to measure resource use by departments in terms of faculty/staff time and faculty/staff salaries. Comparisons between the graduate teaching program and the undergraduate program show some differences between and among universities.

CHAPTER V. ECONOMIC MODEL APPLICATION

In this section, an economic model is conceptualized for the undergraduate agricultural education curriculum. The model is a basic supply and demand model. From the basic model, two smaller submodels are hypothesized using the data collected from the study departments. One submodel deals with a production function, and several empirical techniques are used to test the form of the production function. The second submodel is merely a linear extraction from the primary model.

Conceptual Model

As indicated in earlier sections of the study, the primary function of an agricultural education department, particularly at the undergraduate level, is to train and prepare students to enter vocational agriculture teaching at the secondary level. This goal and mission is somewhat universal among all the departments in the north central region and could be further hypothesized to extend throughout the continental United States. From an economic standpoint, a model could be conceptualized that would include two primary economic factors -- the supply of teachers entering the profession and the demand for graduates to teach vocational agriculture at the secondary level. The fundamental relationship in an equilibrium position would indicate that the supply of teachers should equal the demand for teachers. The supply of teachers is a function of the capacity of the agricultural education departments in the land grant university. The quantity of staff available to teach and supervise students, the capital in dollars spent for salaries and overhead, and the amount of physical space available for classrooms, laboratories, library, etc., are variables that affect the supply of teachers. The supply curve then could be hypothesized to be upward sloping and to the right. Therefore, as the number of teachers graduating from a variable amount of resources used to train and prepare teachers increases, the unit cost of preparing a teacher tends to increase.

On the other hand, it is hypothesized that the demand curve for teachers is downward sloping and to the right. Therefore, as the quantity of teachers increases, the "price paid" in terms of a starting salary tends to decrease. The demand for teachers is affected by the local school administrator, school board, and other governing bodies as they fill vacancies, expand current programs, or start new programs. Another major factor influencing the demand for teachers is employment opportunities outside vocational agriculture teaching. That is, vocational agriculture teachers tend to be a mobile labor resource, and if salaries in other professions become more attractive relative to vocational agriculture teaching salaries, some teachers will leave vocational agriculture teaching for other employment opportunities.

If the demand curve for vocational agriculture teachers is downward sloping to the right and the supply curve is upward sloping to the right, then there must be an equilibrium point where supply equals demand and a resulting equilibrium "price" in terms of starting salaries and equilibrium "quantity" in terms of teachers employed to meet the demand. Figure 5.1 portrays that supply-demand situation.

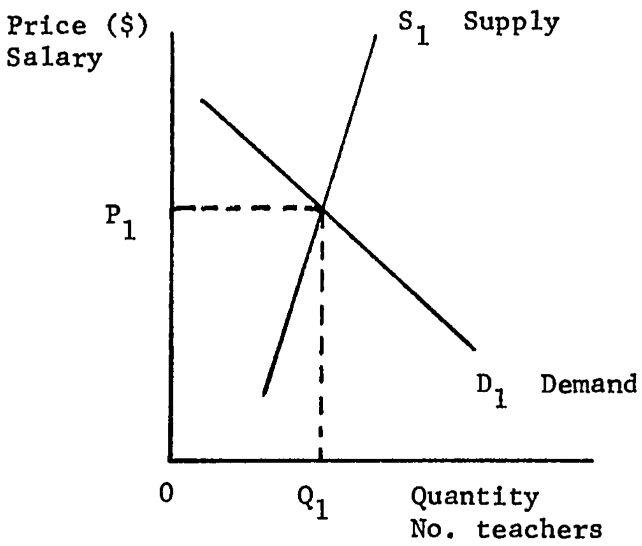

Figure 5.1. Supply and demand curves for vocational agriculture teachers at the secondary level with resulting equilibrium prices and quantity

In Figure 5.1, the curve S_1 represents the supply of teachers, while the curve D_1 represents the demand for teachers. P_1 represents the equilibrium price or salary, while Q_1 is the equilibrium quantity. At price, P_1, then, the supply of teachers needed will exactly equal the quantity demanded and an equilibrium situation will exist.

The quantity of teachers supplied the profession can be defined in terms of two variables. The first variable is the actual number of graduates in agricultural education, and the second variable is the entry rate or the percent of graduates that enter teaching. The supply function can be explained by the following equation:

$$S = Y \cdot Z$$

In this equation S represents the number of teachers entering teaching or the supply of new teachers. Y is a functional relationship explaining the relationship of the number of graduates to resources used, and Z is the functional relationship for the entry rate.

The number of graduates is hypothesized to be a function of the quantity of resources used to train and prepare teachers for the undergraduate program and can be expressed by the following mathematical relationship:

$$Y = f(X_1, X_2, X_3 \ldots X_n).$$

This functional relationship, known as a production function, represents a mathematical input-output relationship between output (number of students graduating) and the inputs used in the production process, such as salaries, staff time, overhead expenses, and the like. Hence, the relationship will show what will happen to the number of graduates as the mix of these factors of production changes. For example, if X_1 represents the quantity of staff time and X_1 increases, the function will measure the positive or negative effect upon the number of graduates from an agricultural education program. Likewise, if X_2 represents salaries and more funds are available for faculty salaries, will this tend to have a positive impact upon the number of graduates?

A mathematical relationship showing what will happen to the entry rate as the various factors from C_1 through C_n change is shown in the following equation.

$$Z = f(C_1, C_2, \ldots C_n).$$

That is to say, if an increase in the factor C_1 has a positive impact upon the entry rate, then there is a positive relationship between C_1 and Z, the entry rate. For example, let's assume that additional funds were made available for counseling and advising. One could hypothesize that if these funds were used for program promotion or more contact with students, then this would have a positive effect upon the entry rate.

Returning to the basic supply and demand model as shown in Figure 5.1, let's assume that the demand for teachers increases. The increase in demand may be due to program expansion at the secondary level, increased vacancies, or other related factors. As shown in Figure 5.2, this shifts the demand curve to the right (as illustrated by D_2). The supply and demand situation is no longer in equilibrium, since demand now exceeds supply and excess demand exists in the industry at the former equilibrium price.

Traditional economic theory would dictate that the price (starting salary) should increase allowing a new equilibrium point where the new

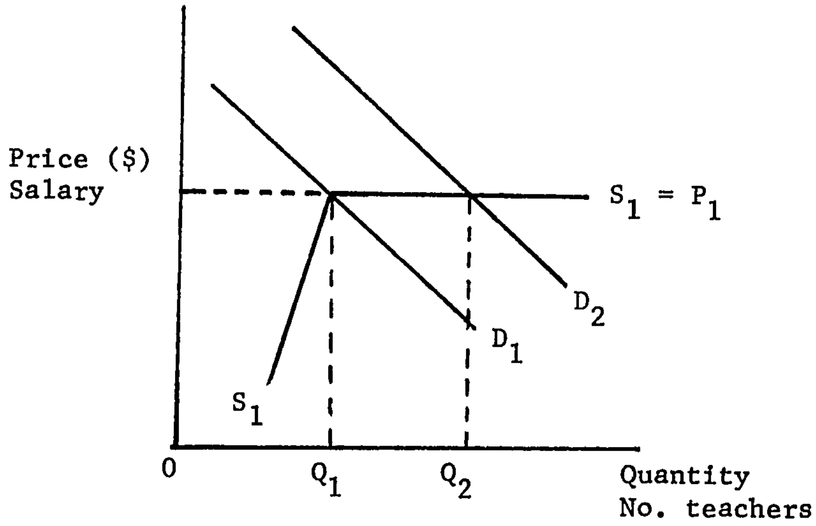

Figure 5.2. Excess demand for vocational agriculture teachers

equilibrium price would be greater than P_1 and a new equilibrium quantity greater than Q_1. But starting salaries may not increase in the short run and thus prevent the market from clearing at a higher price. There are several reasons to expect that starting salaries may not increase. School budgets may be fixed with money resources already allocated for vocational agriculture teaching salaries. Administrators may be limited by voluntary wage guidelines allowing for little or no increases. Teachers' salaries may have already been determined by contracts that have been previously negotiated. Administrators may be reluctant to increase vocational agriculture teaching salaries faster than other teaching salaries in the same school system. Hence, the starting salary or price in the model may be very sticky upward or rigid. Even if the salaries would rise, it is argued that the "real" salaries, that is, the nominal salaries discounted for inflation, are probably fixed or perhaps downward sloping. With high rates of inflation, nominal salaries are not keeping ahead of the changes in the rate of inflation, and hence, the real salaries may be declining or at best remaining constant.

Assume that nominal salaries are constant and that the supply curve then tends to move along the price line where P_1 equals S_1. With excess demand for vocational agriculture teachers now existing in the industry, as shown by D_1-D_2 in Figure 5.2, land grant university agricultural education programs are called upon to increase supply so as to achieve equilibrium at the existing salary level. Two plausible strategies exist.

First, if the student population is available and starting salaries are reasonably competitive, then additional students should enter teaching if added resources are added to the department, with these resources being used for the training, supervision, and preparation of undergraduate students for vocational agriculture teaching at the secondary level. That is, if the quantity of staff time used to train and prepare students were to double, then the number of students entering teaching should increase. The exact percentage change is not known and can be empirically tested. This relationship is the production function relationship as earlier shown.

Secondly, the entry rate can be influenced by the departmental administrator and the staff. Resources can be substituted from some other function within the department and used in the undergraduate program to increase the entry rate. For example, staff and money resources could be taken from the graduate teaching and research program and used in the undergraduate advising program to increase the entry rate. More time might be spent on counseling with students, more time spent on experiences in classroom teaching, more time spent on supervised teaching and occupational experience, and more time spent on developing materials and working with local school administrators. Increases in these activities could have a positive impact upon the entry rate. In this case, it is assumed that all departmental resources are fully employed and utilized and that additional resources are not available. Hence, there is some substitution effect as resources are moved from one functional area to another. It is also assumed that the resources within the department are fairly mobile and can be transferred from one function to another. If the departmental executive officer or university administrator responds by either method as outlined earlier, there is a new supply and demand equilibrium point which then would be reached at P_1 and Q_2.

Empirical Results

Production function

The number of students entering teaching is hypothesized to be a function of the inputs used in the teaching process including faculty time, salaries, classroom space, library space, books available, and the like. A production function is formulated in the following manner:

$$Y = f(X_{10}, X_{20}, X_{30} | X_{40}, X_{50}, X_{60} \ldots X_n).$$

Y is the output factor and in this case is the number of students graduating from agricultural education programs. The X's represent the input factors of production. For this specific model, some factors were considered to be variable while others were treated as fixed factors of production. Three variable factors of production are considered. They are: full-time faculty equivalents used in the undergraduate program, faculty/staff salaries allocated to the undergraduate program, and average class size.

The number of full-time equivalents (FTE's) is a measure of the "labor" input used in the production process. For the purposes of this model, it is assumed that FTE's can be added or deleted from the production process in fractional units. That is to say, labor (FTE's) is not a "lumpy" input that must be added in terms of single "whole" units. Even though staff are added in terms of total units, time allocation per staff can be added by fractional units, since the staff members' responsibilities can be allocated among several functions.

Salaries used to support the staff working in the undergraduate program is a proxy for the capital input into the production function. Again, it is assumed that salaries can be added in dollar increments rather than unit cost increments. By allowing fractional increments of staff and dollars, a smooth and continuous production function can be formulated.

Average class size is considered to be a variable input as a proxy for classroom space. While this may not be the best measure of this input, it is the best proxy in terms of data collected from the study departments.

Fixed inputs in the production process as denoted by the variables ($X_{40} \ldots X_n$) are considered to be support staff and their costs, library and laboratory space, teaching equipment and supplies, books, and the like. These don't change as the level of output changes and are a fixed factor in the total production process.

Data were collected from each study department on the output measure, and the variable input factors and several different production function models were tested. These models included linear models as well as linear approximations to curvilinear models. The production function models tested are as follows:

Cobb-Douglas: $Y = aX_i^b$

$$Y = aX_i^{b_i} X_j^{b_j}$$

$$Y = aX_i^{b_i} X_j^{b_j} X_k^{b_k}$$

Quadratic form: $Y = a + b_iX_i - b_jX_i^2$

$$Y = a + b_iX_i + b_jX_j - b_kX_i^2 - b_lX_j^2 + b_mX_iX_j$$

Square root: $Y = a - b_iX_i + b_jX_i^{.5}$.

Linear regression techniques were used to estimate each of the functions. In the case of the Cobb-Douglas function, a logarithmic estimation was made. All other functions were estimated directly via a linear model. The R-square, F-ratio (ratio of mean squares), and prediction equation for each model are reported in Figure 5.3.

Quadratic functions Three quadratic prediction equations were found statistically significant. One prediction equation is statistically significant at $p < .025$, and two equations are significant at $p < .25$. Prediction equations 11 and 12 are significant at $p < .25$. Prediction equation 11 measures the interaction between faculty/staff time and the number of graduates. Prediction equation 12 measures the response between faculty/staff salaries and the number of graduates. The third significant equation is prediction equation 15, which measures the interaction between average class size and faculty/staff salaries. All other quadratic formulations are not significant and therefore do not adequately explain the variation in output as a function of the inputs.

The quadratic model containing the two variables X_{12} (average class size) and X_{13} (faculty salaries) is significant at $p < .025$. Statistical analysis indicates that the interaction term $b_mX_iX_j$ is not significant in this case and hence $b_5X_{12}X_{13} = 0$. The prediction equation explains 99% of the variation in the data set at the 99.5%

Model	X variable	R^2	F-ratio	Prediction equation number	Prediction equation
Cobb-Douglas function					
$Y = aX_i^b$	X_7	.37	3.58*	1	$Y^* = 1.82X_7^{.65}$
	X_{13}	.31	2.68*	2	$Y^* = -.14X_{13}^{.46}$
	X_{12}	.03	.23	3	$Y^* = 1.90X_{12}^{.12}$
$Y = aX_i^{b_i}X_j^{b_j}$	X_7, X_{13}	.38	2.22*	4	$Y^* = 2.60X_7^{.87}X_{13}^{-.18}$
	X_7, X_{12}	.40	1.68*	5	$Y^* = 1.92X_7^{.77}X_{12}^{-.12}$
	X_{12}, X_{13}	.32	1.16	6	$Y^* = -.28X_{12}^{-.07}X_{13}^{.51}$
$Y = aX_i^{b_i}X_j^{b_j}X_k^{b_k}$	X_7, X_{12}, X_{13}	.41	.92	7	$Y^* = 2.89X_7^{1.05}X_{13}^{-.22}X_{12}^{-.12}$
Square root function					
$Y = a - b_iX_i + b_jX_i^{.5}$	X_7	.52	2.68*	8	$Y^* = 145.35 + 71.58X_7 - 130.73X_7^{.5}$
	X_{13}	.43	1.92*	9	$Y^* = -46.82 + .0011X_{13} - .96X_{13}^{.5}$
	X_{12}	.12	.37	10	$Y^* = 126.77 - 5.53X_{12} + 25.75X_{12}^{.5}$

*Significant at $p < .25$.

Figure 5.3. Prediction equations for the Cobb-Douglas, quadratic, and square root functions for the undergraduate teaching program

Model	X variable	R^2	F-ratio	Prediction equation number	Prediction equation
Quadratic function					
$Y = a + b_iX_i - b_jX_i^2$	X_7	.52	2.68*	11	$Y^* = 71.46 + 7.12X_7 - 4.52X_7^2$
	X_{13}	.44	1.94*	12	$Y^* = 39.04 + .0018X_{13} - .0000000078X_{13}^2$
	X_{12}	.15	.43	13	$Y^* = 103.18 - 1.29X_{12} - .12X_{12}^2$
$Y = a + b_iX_i + b_jX_j - b_kX_i^2 - b_lX_j^2 + b_mX_iX_j$					
	X_7, X_{13}	.58	.56	14	$Y^* = 151.60 + 118.83X_7 - .0081X_{13} + 34.37X_7^2 - .0000000049X_{13}^2 - .0022X_7X_{13}$
	X_{12}, X_{13}	.99	68.53**	15	$Y^* = 59.12 + 77.50X_{12} - .016X_{13} + 1.03X_{12}^2 - .00000039X_{13}^2 - .0015X_{12}X_{13}$

**Significant at $p < .025$.

Figure 5.3. (Continued)

probability level. However, it should be noted that only one degree of freedom exists for the residual sum of squares and a reasonably "good" fit of the data to the prediction model would be expected.

The marginal products (changes in Y for unit changes in X) are as follows:

$$\frac{\partial Y}{\partial X_{12}} = 77.50 + 2.06X_{12}$$

$$\frac{\partial Y}{\partial X_{13}} = -.016 - .00000078X_{13}.$$

From production function theory, it can be shown that total product is at a maximum when marginal products is equal to zero. Hence, for these two equations, the point where total product is at a maximum can be found by setting these equations equal to zero and solving for the appropriate value of X_{12} and X_{13}.

$$77.50 + 2.06X_{12} = 0$$

$$2.06X_{12} = -77.50$$

$$X_{12} = -37.62$$

$$-.016 - .00000078X_{13} = 0$$

$$- .00000078X_{13} = .016$$

$$X_{13} = -20{,}512.$$

Since negative inputs into the production process are not feasible, and, indeed, do not make any economic sense, this production model is rejected as a reasonable estimation of the production function.

The quadratic model estimated by squaring the variable input is statistically significant in two cases as noted by prediction equations 11 and 12. Prediction equation 11 explains 52% of the variation, and prediction equation 12 explains 44% of the variation. Both are significant at $p < .25$.

For prediction equation 11, the marginal product of X_7 (number of FTE's) can be found as follows:

$$\frac{\partial Y}{\partial X_7} = 7.12 - 9.04X_7.$$

The point where total product reaches a maximum is found by setting the marginal product equation equal to zero and solving for the number of FTE's. The results indicate that total product is at a maximum at 1.27 full-time equivalents.

Likewise, for prediction equation 12, the marginal product of salaries measured in dollars is:

$$\frac{\partial Y}{\partial X_{13}} = .0018 - .00000056X_{13}.$$

The point of maximum total production and where marginal product equals zero is $11,538.46.

In the case of the number of FTE's, the total product reaches a maximum at 1.27 full-time equivalents, and increases beyond this point indicate decreasing total product and negative marginal productivity. Likewise, similar conclusions can be drawn for faculty salaries. Both of these prediction equations may have limited application and usefulness because of these results. Most departments already exceed 1.27 full-time equivalents and hence would be operating the region of negative marginal productivity. Intuitively, this does not seem reasonable.

Square root function The square root function as estimated by prediction equations 8, 9, and 10 is significant in two equations. Prediction equations 8 and 9 are significant at $p < .25$ and explain 43% to 52% of the variation of the output variable due to the input variable.

For prediction equation 8, the marginal product of FTE's is

$$\frac{\partial X}{\partial X_7} = -71.58 - 65.36X_7^{-.5}.$$

Solving for the point of maximum total production reveals that declining marginal productivity will occur when the number of FTE's used in the undergraduate program exceeds .83 full-time equivalents. For prediction equation 9, similar analysis reveals negative marginal productivity beyond $190,413 (approximately 9 full-time equivalents). Prediction equation 9 is a better prediction of the dependent variable.

Cobb-Douglas function Two Cobb-Douglas prediction equations with one variable input are significant at $p < .25$ or 75% significance level. However, neither equation showed a very high R^2. The equations that were significant contained the FTE and salary variable, respectively.

The prediction equation (equation 1) for the number of FTE's and its relationship to output is as follows:

$$Y^* = 1.82X_7^{.65}.$$

Although the equation is significant and has a relatively low R^2, it still explains a portion of the variation due to the number of FTE's. The estimated prediction equation contains many properties that have important implications to the resource allocation within the study departments.

The marginal product of the prediction equation is:

$$\frac{\partial Y}{\partial X_7} = \frac{1.18X_7^{.65}}{X_7}\ .$$

From the marginal product equation, it is apparent that the marginal product of the FTE's will never equal zero and that total product never reaches a maximum. Several examples will illustrate this point. When X = 1, the marginal product is 1.18. If X increases to 10, then the marginal product is .52. Increasing X to 100 causes the marginal product to decline to .24. Hence, as the number of full-time faculty equivalents increase, the marginal product decreases, while total product increases but increases at a decreasing rate. The coefficient b indicates the relationship between marginal product and total product. For this equation, $b < 1$, which indicates that the magnitude of the marginal products will decline as the level of X_7 increases, since $X_7^b < X_7$.

The elasticity of production is another important property of this type of production that has important economic implications to resource allocation within the study departments.

The elasticity of production measures the percentage change in output due to a percentage change in inputs. The elasticity of production is calculated as follows:

$$\frac{\%\Delta Y}{\%\Delta X} = \frac{\partial Y}{\partial X} \cdot \frac{X}{Y} = \frac{baX^{b-1}X}{Y} = \frac{baX^b}{Y} = \frac{bY}{Y} = b.$$

Hence, the elasticity of production can be determined directly from the production function and is the coefficient of production, b.

In the case of the number of FTE's, the elasticity of production is .65, which means that over the range of production, a 1% increase in the number of FTE's will increase the output by .65%. That is, a 10% increase in staff used in the undergraduate program will increase the number of teachers entering teaching by 6.5%, assuming that the entry rate does not change.

A similar analysis can be made for the production function estimation of salaries, as shown by prediction equation 2. The marginal product for this function is:

$$\frac{\partial Y}{\partial X_{13}} = \frac{-.06X_{13}^{.46}}{X_{13}} .$$

The marginal product is both positive and negative. For small values, say $X_{13} = 1$, the marginal product is negative. As X_{13} increases, the marginal product increases. For example, when $X_{13} = 5$, the marginal product is negative (-.03), but when $X_{13} = 25$, the value of the marginal product is positive (.01).

The elasticity of production is estimated from the prediction equation as the coefficient of production. In this case, the elasticity of production is equal to .46, indicating that a 10% in staff dollars would increase the number of students graduating by 4.6%.

Two prediction equations of the Cobb-Douglas form are significant when two variable inputs are included. These are prediction equations 4 and 5. Prediction equation 4 measures the response of the number of students graduating by faculty/staff time and salaries. Prediction equation 5 measures the response from average class size and faculty/staff time.

Both equations contain the same properties as the Cobb-Douglas equations with one variable input. The sum of the elasticities is less than one, indicating decreasing marginal productivity and decreasing returns to scale.

In summary, the Cobb-Douglas functions seem the most reasonable estimation of the production function. The inputs reveal diminishing marginal productivity, which one would expect. As departmental size increases in FTE's or dollars, the marginal change in output per unit of input would continue to be smaller and smaller.

Entry function

The second factor in the equation for the number of teachers entering teaching is the entry rate. As previously discussed, the entry rate is hypothesized to be a function as follows:

$$Z = f(C_1 \ldots C_n).$$

Several variables are identified to have a demonstrable effect upon Z (the percentage of teachers entering teaching). Data were collected from the study departments on the following factors:

(1) Percentage of staff time spent on undergraduate advising.

(2) Percentage of staff spent on undergraduate teaching.

(3) Percentage of salaries spent on undergraduate advising.

(4) Percentage of salaries spent on undergraduate teaching.

(5) Departmental size.

A linear model is formulated to test the relationship between these variables and the dependent variable, the entry rate. A specific model is proposed as:

$$Z = a + b_1C_1 + b_2C_2 + b_3C_3 + b_4C_4$$

where

C_1 = Percent time devoted to undergraduate advising

C_2 = Percent time devoted to undergraduate teaching

C_3 = Percent salaries used for undergraduate advising

C_4 = Percent salaries used for undergraduate teaching.

The model was tested using least squares estimation with different combinations of the independent variables and a stepwise inclusion of all variables.

The specific combinations tested were Y (dependent variable with C_1; C_1 and C_2; C_3; C_3 and C_4). In addition, dummy variables for departmental size and departmental affiliation were included in the model. Solutions to the model were obtained both with and without the dummy variables.

The results of these regression solutions indicated that none of the independent variables were significant ($p < .25$). The dummy variables were not significant at the same level of significance when included in the regression analysis. Hence, departmental size and college affiliation had no impact upon the time or money spent for advising which in turn had no impact upon the entry rate.

An additional analysis was made to test the data for a curvilinear fit instead of a linear least squares estimation. A dummy variable was included in the model to see if the proportion of variation that can be accounted for by a curvilinear model is greater than that for a linear estimation. The study departments were divided on the basis of the percentage of time spent on undergraduate advising. Two classifications were used -- those departments under 10% compared to those departments over 10%. The solution to this model is found not to be unique, since one variable exceeded the tolerance level. Hence, it can be concluded that the data do not fit a curvilinear model better than a linear approximation.

It would appear that the above variables do not explain the variation in the dependent variable. Other variables explaining the entry rate are not included in this study. Perhaps the entry rate can be explained by the "price" phenomena or nominal starting salaries relative to other opportunities. Data or salary costs for the local school district could be compared to other income measures, such as farm income, or starting salaries in other agribusiness occupations. The ratio of salaries for vocational agriculture teachers to some other index of salaries and wages could be compared to the entry rate. This analysis was beyond the scope of this study.

CHAPTER VI. SUMMARY, IMPLICATIONS, CONCLUSIONS, RECOMMENDATIONS

Agricultural education in the land grant university is an integral part of the total university. Both as a curriculum and discipline, it has contributions to make to the total body of agricultural research and the placement of graduates in agricultural teaching and agribusiness.

This study attempted to assess the current resource use in agricultural education departments in the north central region by quantifying and describing resources used in the undergraduate teaching/advising, graduate teaching, in-service/extension, and administrative functions of the departments.

The study also attempted to analyze the supply of agricultural teachers graduating from the undergraduate program with an economic model. A model is formulated where the number of students entering teaching is a function of the number of graduates entering teaching and the entry rate (percentage of graduates entering teaching).

Data were collected from departmental executive officers in agricultural education departments in the north central region of the United States. Eight of 12 department heads responded to the survey.

Summary of Descriptive Results

Information was collected from the departmental executive officers on the organizational structure and college affiliation of their departments. Demographic and experience data on the faculty/staff were also collected. Faculty/staff time, faculty/staff salaries constitute major inputs into the educational system of the land grant university. Data on faculty/staff time and salaries by major functional area were also collected from the departments. Furthermore, the data were subdivided into major program areas within each function. Lastly, data on the numbers of students graduating from the program were collected. All input and output data were collected for the 1978-1979 year.

The type of organizational system in 1978-1979 for the agricultural education programs is nearly divided between being organized as a department within a college or a section within a department. However, there is some correlation between departmental affiliation and departmental organization. Those programs organized as departments are more closely affiliated with the college of agriculture, while the programs organized as a section within a department are affiliated with the college of education.

Some variety of degree programs offered occurs among the departments. All programs offer a bachelor of science degree; however, for advanced degrees, there are wide differences among the institutions with some offering master of science, master of arts, master of education, doctor of philosophy, and doctor of education degrees.

Output factors measured in the study were the number of graduates, the number of credits offered during the year, and the number of student credit hours taught during the year.

For the 1978-1979 academic year, a total of 275 students graduated from the undergraduate program. Of this total, 164 or 59.6% selected teaching vocational agriculture as their first occupation. On the graduate level, a total of 131 degrees were conferred.

The number of semester credits offered in the undergraduate program varied from 24 credits to 69 credits with a mean of 45 credits. The number of semester contact hours also varied from 331 to 1,254 semester student credit hours.

Faculty/staff time and faculty/staff salaries and overhead costs are two important inputs into the educational process of the department. For the 1978-1979 year, the undergraduate program required the largest amount of time with 36.1% of the total faculty/staff time. The next largest time user was the research program with 26.7% followed by the graduate teaching/advising program with 15.1%. The undergraduate program is and continues to be the strongest program emphasis within each department. Similar results are noted for salaries used to support the faculty. In 1978-1979, over two-thirds of salaries were used to support the staff in the undergraduate program with the research and graduate teaching programs in that order with each using less than 20% of the total salaries.

Various input/output measures were calculated from the data. These input/output measures were calculated from the data. These input/output measures examined the relationships between salaries, time, students, and credit contact hours. Furthermore, the study departments were divided into two size groupings (greater and less than 120 undergraduate students) to see if differences existed by sizes. Statistical analysis revealed that the salary costs per full-time equivalent (FTE) are significantly different in graduate and research functions of the study departments. Other salary costs per FTE were not statistically significant.

Statistical analysis shows that time use by departments is not greatly different by size of department. Only the amount of research is significantly different. The percent of time used in the other functional areas is not significantly different.

Semester credits per FTE in the graduate program is significantly different among the departments in the salary cost per semester credit. These differences are due to the nature of the departments and the differences in graduate program emphasis. The largest departments tended to have higher costs per credit, because they tended to offer a more diversified program with many having a master's and Ph.D. degree. These departments had lower teaching loads per faculty; thus, the number of faculty with graduate appointments was larger.

Summary of Economic Model

A conceptual model and an empirical test of the model is formulated for the undergraduate teaching program. The conceptual model incorporated as inputs a production function and a least squares estimation with the number of students graduating and the entry rate as input factors.

For the production function estimation, the inputs in the model are the number of full-time equivalents and salaries. The production function model was tested using several different approaches. Prediction equations were estimated for two quadratic forms, a square root form, and several Cobb-Douglas forms. Only the Cobb-Douglas form was found significant with the number of full-time equivalents of faculty and salaries being the input factors. For this formulation of the model, it was found that a 10% change in the number of FTE's used in the undergraduate program would increase the number of students graduating by 6.5% when the entry rate is held constant.

The entry rate was also analyzed using multiple regression techniques. Variables tested included the percent of staff time spent in advising, and the percent of funds used for advising. These were also analyzed by size of department and college affiliation. None of these variables is significant. Hence, a mathematical formulation of the model cannot be made. Other variables might explain the variation in the entry rate, but these variables were not included as a part of this study.

Implications and Recommendations

This study has implications to the agricultural education departments in the north central region. Some inferences might be drawn to all departments found in the United States, although these departments were not included in the study area. The study focuses upon implications and recommendations as related to staffing, funding, departmental structure, and organization.

From the study, it would appear that there is an equitable distribution between salaries and faculty time within most functions, particularly the undergraduate teaching, graduate teaching, and in-service functions. However, a greater disparity exists between faculty/staff salaries and faculty/staff time in research. Graduate research assistants and non-tenured faculty under the direction of tenured faculty tend to conduct nearly all of the research in a department. Is this a judicious use of resources? While this study cannot answer this question directly, since it was not specifically addressed within the study, these data collected would intuitively support the conclusion that these resources are justifiably used correctly. When posed the question regarding resource allocation within a department, the departmental executive officers expressed the desire to expand research efforts by diverting resources away from undergraduate teaching, particularly when no additional resources are available. Responses indicated a desire to expand research efforts when unlimited resources are available. Both efforts could be achieved. Resources could be expanded by adding both professional staff and graduate assistants. For every one full-time equivalent professional faculty member, approximately five graduate assistants could be added at the same salary cost. By the same token, for every added FTE in faculty/staff time, five to ten graduate assistants could be added to conduct research.

The amount of in-service/extension time within many departments is quite small, in fact, less than 10% in most cases. For the beginning teacher in his/her first year of teaching, this poses a question on how that teacher receives the needed supervision and training. Logically, this function is the responsibility of the land grant university. A strong in-service training program led by an experienced faculty member could bridge the gap between the teacher placement function of the land grant university department and the local school district. Continual and frequent in-service training is needed to up-date the teacher on technical agriculture and changes in teaching methods, design, and the like. Such a program would greatly enhance the working relationship between the local district and the university.

The relatively low percentage of outside funds from grants and contracts to the departments is somewhat surprising. While the majority of funding should be from federal and state sources, private industry, non-profit educational foundations as a source of grants and gifts is a vital part of the funding process. From the data, it appears that additional administrative efforts in this area could be made.

Accountability of funds and time by public agencies is surfacing as an ever important issue in today's society. Taxpayers, administrators, and government agencies show greater concern for the accountability of funds and the justification of program expenditures. Educational program evaluation and principles of evaluation including the application of these principles will become more important topics in the future. The agricultural education curriculum combined with other physical and social sciences could increase their efforts in this area.

As commercial agriculture becomes more capitalized and farms become larger and fewer in number, the direction and scope of FFA and occupational experience programs may have to change to accommodate these changes. More students will demand off-farm experiences, and the agricultural education departments should provide leadership in helping analyze the changes within the local school program, particularly as it related to SOE and FFA programs.

The economic model explains how the university can respond to the supply-demand conditions of the agriculture teacher shortage problem when teacher salaries are inflexible. Universities can respond by trying to improve the entry rate or by increasing the number of graduates by altering the resource mix within the agricultural education program. The model also has implications to other departments where similar situations exist.

This study is a cross-sectional analysis of the departments in the region. The data set can serve as a model for future data sets. It is hoped from this study that self-assessment and inventory within each department will occur. This is where the full benefit of the study will occur. Self-evaluation is an important concept in the total evaluation process.

Needs for Future Research

The inability of the study to adequately explain in economic terms the variation in entry rate poses some additional needs for research. The entry rate may not be an economic phenomena in which case the sociological, psychological, and educational factors affecting the decision-making process of students need study. If the entry rate is an economic factor, this study failed to identify the economic variables affecting the entry rate, and future studies could be done.

More data need to be collected on the capital costs within the agricultural education departments. Data on travel costs, overhead expenses, and related items for the various functions could be included in economic models to aid in analyzing the substitution effect of various inputs. Critical decisions will have to be made by department heads in the future as costs continue to rise and more accountability occurs in the future. Cost-benefit studies of various functions within a department would be helpful in making decisions.

More standards need to be developed and tested on teaching loads, advising loads, and the like that affect faculty/staff time. The current agribusiness/agricultural education standards project is a step in that direction, but more research to verify the recommendations is needed. This study tends to confirm some of these standards but disputes others. In these cases, when a wide difference occurs, either the standards need to be reviewed, or the study departments are unique with respect to the particular standard involved. Basic quantitative educational research in this area could bridge that gap.

This study is also an attempt to apply basic production economic theory to an educational process. It appears that some applications are possible; however, more studies need to be made to improve the application of these models. Perhaps other studies will follow this one.

BIBLIOGRAPHY

1. Cobb, C. W., and Paul H. Douglas. 1928. A theory of production. American Economic Review 18:139-156.

2. Coleman, J. A. 1966. Equality of educational opportunity. OE-38001. U.S. Office of Education, U.S. Department of Health, Education, and Welfare, Washington, D.C.

3. Craig, David G. 1979. A national study of the supply and demand for teachers of vocational agriculture in 1978. University of Tennessee, Knoxville, Tennessee. 26 pp.

4. Crawford, Harold R., Richard I. Carter, and W. Lee Holmes. 1977. Standards for quality vocational programs in agriculture/agribusiness education. Agricultural Education Department, Iowa State University, Ames, Iowa.

5. Flangan, John C. 1962. Project TALENT: Studies of the American high school. Cooperative Research Project No. 226. University of Pittsburgh, Pittsburgh, Pennsylvania.

6. Heady, E. O., and J. L. Dillon. 1964. Agricultural production functions. The Iowa State University Press, Ames, Iowa. 667 pp.

7. Hirsch, W. Z. 1961. Measuring social services in John C. Bollens. Exploring the Metropolitan Community. University of California, Berkeley, California.

8. Huffman, Wallace E. 1976. The productive value of human time in U.S. agriculture. American Journal of Agricultural Economics 58:670-683.

9. Jensen, E. 1941. Input-output relationships in milk production. Technical Bulletin 815. United States Department of Agriculture, Washington, D.C.

10. Katzman, Martin T. 1968. Distribution and production in a big city elementary school system. Yale Economic Essays No. 8: 201-256. Yale University, New Haven, Connecticut.

11. Kiesling, Herbert J. 1969. The relationship of school inputs to public school performance in New York state. Pamphlet 4211. Rand Corporation, Santa Monica, California.

12. Mollenkopf, W. G., and S. D. Melville. 1956. A study of secondary school characteristics as related to test scores. Research Bulletin RB-56-6. Educational Testing Service, Princeton, New Jersey.

13. Nie, Norman H., C. Hadlai Hull, Jean G. Jenkins, Karin Steinbrenner, and Dale H. Bent. 1975. Statistical package for the social sciences. 2nd edition. McGraw-Hill Book Company, New York, New York. 675 pp.

14. Patrick, George E., and Earl W. Kehrberg. 1973. Costs and returns of education in five agricultural areas of Brazil. American Journal of Agricultural Economics 55:145-153.

15. Professional Workers in State Agricultural Experiment Station and Other Cooperating State Institutions. 1977-1978. Agriculture Handbook No. 305. Cooperative State Research Service. United States Department of Agriculture, Washington, D.C.

16. Smith, Marshall S. 1971. Equality of educational opportunity: The basic findings reconsidered. Unpublished paper. Center for Educational Policy Research, Harvard Graduate School of Education, Cambridge, Massachusetts.

17. Snedecor, George W., and W. G. Cochran. 1967. Statistical methods. 6th edition. The Iowa State University Press, Ames, Iowa. 593 pp.

18. Thomas, J. A. 1962. Efficiency in education: A study of the relationship between selected inputs and mean test scores in a sample of senior high schools. Unpublished Ph.D. dissertation. Stanford University, Stanford, California.

19. Zimmer, John M. 1967. Expenditures for public elementary and secondary education in counties classified by the relative poverty states of their rural populations. Journal of Farm Economics 49:1204-1208.

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APPENDIX. SURVEY INSTRUMENT

IOWA STATE UNIVERSITY
AMES, IOWA

SURVEY OF AGRICULTURAL EDUCATION PROGRAMS AT LAND-GRANT UNIVERSITIES IN THE NORTH CENTRAL REGION

I voluntarily agree to participate in this survey of Agricultural Education programs at land-grant universities which is being conducted by the Department of Agricultural Education at Iowa State University. I understand that the purpose of this survey is to gather and analyze data regarding Agricultural Education programs and that the information provided will be held in confidence. Responses may be reported by institution or university but not by individuals working within an institution. Responses will be combined as much as possible.

_______________ (Date) ______________________________ (University)

______________________________ (Signature)

PART I. GENERAL INFORMATION

1. Name of College/University ______________________________

2. Location (City) ________________________ State __________

3. Ag. Education Department Head or Section Chairman

   ____
   (Name)

   ____
   ____
   ____
   (Address)

   (Area) _____ - ____________________________
   (Office telephone number)

4. Department or Section Name (Check one)

   _____ Agricultural Education
   _____ Agricultural Education and Extension Education
   _____ Other (please describe)

   ____
   ____

5. How is your program organized? (Check most appropriate answer)

_____ Department within a college
_____ Section within a department or college

6. Check the description regarding departmental affiliation that best describes your program. Mark one answer only.

_____ a. Affiliated with College of Agriculture only
_____ b. Affiliated with College of Agriculture but staff have cooperating appointments in College of Education
_____ c. Affiliated with College of Education only
_____ d. Affiliated with College of Education but staff have cooperating appointments in College of Agriculture
_____ e. Affiliated with College of Extension Education only
_____ f. Affiliated with College of Extension Education but staff have cooperating appointments in other college(s)

7. How many years including the 1978-79 academic year have you been department head or chairperson? _____years

8. Description of instructional system followed including class length, number of hours per class period, and number of weeks per period.

a. Check the instructional system followed by your university.
_____ quarter system _____ semester system

b. If your answer to a. is the "quarter" system, what is the "normal" length of the academic quarter? _____ weeks

c. If your answer to a. is the "semester" system, what is the "normal" length of the academic semester? _____ weeks

d. What is the "normal" length in minutes of lecture classes on campus? _____ minutes

e. What is the "normal" length in minutes of laboratory classes on campus? _____ minutes

f. If your university program is on the quarter system, please check the following items that "best" describe your teaching system.

_____ 1 hour per week is equivalent to 1 hour of credit
_____ 2 hours per week is equivalent to 2 hours of credit
_____ 3 hours per week is equivalent to 3 hours of credit
_____ 2 hours of lab per week is equivalent to 1 hour of lecture/recitation
_____ None of these describe the teaching system. Please describe your system briefly:

8. If your university program is on the semester system, please check the following items that "best describe your teaching system."

_____ 1 hour per week is equivalent to 1 hour of credit
_____ 2 hours per week is equivalent to 2 hours of credit
_____ 3 hours per week is equivalent to 3 hours of credit
_____ 2 hours of lab per week is equivalent to 1 hour of lecture
_____ None of these describe the teaching system. Please describe your system briefly:

9. Degree programs offered. Check those degree programs offered by your department.

_____ B.S. in Agricultural Education
_____ B.S. in Agricultural Extension Education
_____ M.S. in Agricultural Education - non-thesis
_____ M.S. in Agricultural Education - thesis required
_____ M.S. in Agricultural Extension Education - non-thesis
_____ M.S. in Agricultural Extension Education - thesis required
_____ M.S. in Education
_____ Ph.D. in Agricultural Education
_____ Ph.D. in Agricultural Extension Education
_____ Ph.D. in Education
_____ Other (please identify)

____

____

10. Sources of funding for department. Fill in the blanks for the 1978-79 academic year indicating the source of funding and amount from each source. Includes salaries, fringe benefits paid by department/university, overhead, and current operating expenses.

Note: Extension funds denote monies from the Cooperative Extension Service used directly in Agricultural Education programs for inservice and other activities. Inservice funds refer to monies from other sources and not Cooperative Extension.

	July 1, 1978 to July 1, 1979	
	Salaries	Other
Teaching, state funds, College of __________	______	______
Teaching, state funds, College of __________	______	______
Research, Ag. Expt. Station	______	______
Research, federal government	______	______
Research, grants and gifts (non-govt.)	______	______
Research, other state funds	______	______
Extension, state funds	______	______
Extension, federal funds	______	______
In-service, state funds (not DPI)*	______	______
In-service, federal funds	______	______
In-service, state DPI funds*	______	______
In-service, grants and gifts (non-govt.)	______	______
Other __________	______	______

* State Department of Public Instruction; could also be known as state department of education; refers to state governmental agency responsible for overseeing local school districts.

PART II. COURSE OFFERINGS, ENROLLMENTS, AND HOURS

1. Agricultural Education undergraduate course offerings during the 1978-79 academic year. List the Ag. Ed. undergraduate courses offered by your department during the 1978-79 academic year. Each course should be placed under a subject matter emphasis. List each course by quarter or semester. Please identify the appropriate semester or quarter; e.g., fall, etc. For courses with more than one subject matter emphasis, divide the course into its appropriate category(ies) and divide the credits accordingly.

	(Semester or quarter)			(Semester or quarter)			(Semester or quarter)			(Semester or quarter)		
Course name and number	Hrs. of credit	No. students starting	No. students completing	Hrs. of credit	No. students starting	No. students completing	Hrs. of credit	No. students starting	No. students completing	Hrs. of credit	No. students starting	No. students completing
Introductory courses												
Occupational experiences												
FFA programs												
Teacher preparation / supervision												
Teaching methods / curriculum												
Seminar - individual instruction*												
Ag. Extension												
Other												

*For variable credit length courses, use mean credits per student and record mean under column "Hrs. of credit".

2. Agricultural Education graduate course offerings during the 1978-79 academic year. List the Ag. Ed. graduate courses offered by your department during the 1978-79 academic year. Include on-campus and off-campus classes. Each course should be placed under a subject matter emphasis. For courses with more than one emphasis, divide the course and credits accordingly.

Course name and number	(Semester or quarter)			(Semester or quarter)			(Semester or quarter)			(Semester or quarter)		
	Hrs. of credit	No. students starting	No. students completing	Hrs. of credit	No. students starting	No. students completing	Hrs. of credit	No. students starting	No. students completing	Hrs. of credit	No. students starting	No. students completing
Curriculum												
Teacher prep/ methods												
Philosophy-policy												
Evaluation												
Leadership												
Guidance												
Administration												
Special topics/ Seminar problems research*												
Ag. Extension												
Other												

*For variable credit length courses, use mean credits per student and record mean under column "Hrs. of credit".

3. <u>In-service and/or Extension activities during the 1978-79 academic year</u>. List the number and type of meetings/activities held during the 1978-79 academic year. Include all classes for non-credit. Be sure to include those activities for which your department had major responsibility in teaching or organizing.

	Total no. activities	Total hours instruction	Total students completing
Audience:			
Secondary teachers	______	______	______
Post-secondary teachers	______	______	______
University/college faculty	______	______	______
Farmers	______	______	______
Others	______	______	______
Totals	______	______	______

PART III. STAFF RESOURCES INCLUDING SALARY, TIME, BACKGROUND INFORMATION

1. Background information on salaried staff including graduate assistants. List below all salaried faculty members including graduate assistants as of July 1, 1978. For each staff member, fill out the table listing characteristics about that faculty member. Include the 1978-1979 year in computing years of experience and employment. Use the last four digits of a staff member's Social Security number for identification. If duplication occurs, increase one staff member's number by one digit.

			Check Degrees Received								
ID No.	Sex	Age	B.S.	M.S.	Ph.D. or E.Ed.	Years employed in your department	Years of professional experience since last degree	Years of high school teaching experience	Years of university teaching experience	Years of total experience	Tenure granted Y=Yes N=No
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											

2. <u>Sources of funding for staff salaries for 1978-79 (July 1, 1978 - July 1, 1979)</u>. List below each individual staff member by ID No., their total salary, and the sources of funds used to support their salary. Note that column 1 must equal column 9 where column 9 is the sum of columns 2 through 8. The total salary listed for each staff member in column 1 includes fringe benefits paid by the university. For salary increases granted during the year, use an average salary paid for the entire year. Recopy the partial Social Security identification number from the previous page.

	ID No.	Total salary (1)	University teaching state funds (2)	Ag. exp. station state funds (3)	University extension state funds (4)	Research monies from other govt. sources (5)	Monies from private industry (6)	DPI funds from state* (7)	Other (8)	Total (9)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										

*May also be known as state department of education; state agency responsible for overseeing the local school districts.

3. Distribution of staff member's time by function, 1978-79. List below for each staff member identified in Part III, Table 1, his/her title, appointment, and responsibility within the department. For the various activities listed, use a percentage allocation in columns 3 through 8. Column 9 should equal 100% and be the sum of columns 3-8. For promotions during the academic year, use the appointment at the beginning of academic year. Recopy the Social Security ID No.

	ID No.	Title[a] (1)	Appointment[b] (2)	Undergraduate teaching[c] (3)	Graduate teaching (4)	Research (5)	In-Service and/or Extension service (6)	Administration (7)	Other (8)	Total[d] (9)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										

[a] P = professor; AP = associate professor; AAP = assistant professor; I = Instructor; G.A. = graduate assistant.

[b] Designations for appointment:
- A = full-time, 12 months, instructor or professorial
- 3/4 A = 3/4 time, 12 months, instructor or professorial
- 1/2 A = 1/2 time, 12 months, instructor or professorial
- B = full-time, 9 months (academic year), instructor or professorial
- 3/4 B = 3/4 time, 9 months (academic year), instructor or professorial
- 1/2 B = 1/2 time, 9 months (academic year), instructor or professorial
- C = full-time, 12 months, graduate assistant
- 3/4 C = 3/4 time, 12 months, graduate assistant
- 1/2 C = 1/2 time, 12 months, graduate assistant
- 1/4 C = 1/4 time, 12 months, graduate assistant
- D = full-time, 9 months, graduate assistant
- 3/4 D = 3/4 time, 9 months, graduate assistant
- 1/2 D = 1/2 time, 9 months, graduate assistant
- 1/4 D = 1/4 time, 9 months, graduate assistant

[c] Includes undergraduate advising of students.

[d] Must total to 100% by summing across columns.

4. <u>Distribution of staff time by percentages in undergraduate teaching and advising by specialized areas of instruction in Agricultural Education in 1978-79</u>. Column 1 data can be found from column 3, Part III, Table 3. Column 9 is the sum of columns 2 through 8 and must equal column 1. Please indicate percentages in whole numbers, e.g., 1/3 = 33%; 1/2 = 50%, etc. Recopy the Social Security ID No. from previous tables.

	ID No.	Percent of total staff member's time from Table 2 (1)	Under-graduate advising (2)	Introductory courses (3)	Occupational experience (4)	FFA programs (5)	Teacher preparation and/or methods (6)	Extension (7)	Other[a] (8)	Total (9)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										

[a]Other includes activities not defined. Please identify and note below.

5. <u>Distribution of staff time by percentages in graduate teaching by specialized areas of instruction in Agricultural Education in 1978-79</u>. Column 1 data can be found from column 4, Part III, Table 3. Column 10 is the sum of columns 2 through 9 and must equal column 1. Please include percentages in whole numbers; e.g., 1/3 = 33%; 1/2 = 50%, etc. Recopy the Social Security ID No. from the previous tables.

	ID No.	Percent of total staff member's time from Table 2 (1)	Curriculum and development (2)	Teacher education and/or methods (3)	Philosophy and/or policy (4)	Evaluation (5)	Leadership and/or guidance (6)	Administration (7)	Other[a] (8)	Extension (9)	Total (10)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

[a]Other includes program emphasis not defined. Please identify and note below.

6. <u>Distribution of staff time by percentages in research by specialized areas in Agricultural Education in 1978-79</u>. Column 1 data can be found from column 5, Part III, Table 3. Column 10 is the sum of columns 2 through 9 and must equal column 1. Please include percentages in whole numbers; i.e., 1/3 = 33%; 1/2 = 50%, etc. Recopy the Social Security ID No. from the previous tables.

	ID No.	Percent of total staff member's time from Table 2 (1)	Curriculum and development (2)	Teacher education and/or methods (3)	Philosophy and/or policy (4)	Evaluation (5)	Leadership and/or guidance (6)	Administration (7)	Other[a] (8)	Extension (9)	Total (10)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

[a]Other includes research emphasis not identified. Please identify and note below.

PART IV. DEPARTMENTAL OUTPUT

1. Fill out the table below for undergraduate departmental majors for the 1978-1979 academic year. Please note that total (1) should equal total (2).

	Male	Female	Total
Undergraduate students -- beginning of year	______	______	______
New enrollees and transfers in during year	______	______	______
Other ______________________	______	______	______
Total (1)			______
Transfers out during year	______	______	______
Dropouts from program during year	______	______	______
B.S. degrees conferred during year	______	______	______
Other ______________________	______	______	______
Undergraduate students, end of year	______	______	______
Total (2)			______

2. Job placement of B.S. graduates in 1978-79. Enter the number of graduates by their first job.

	Male	Female	Total
Vocational ag. teaching (secondary)	______	______	______
Agricultural teaching (post-secondary)	______	______	______
Agricultural extension	______	______	______
Agricultural business	______	______	______
Farming	______	______	______
Graduate school	______	______	______
Other	______	______	______
Total	______	______	______

3. Graduate departmental majors at beginning and end of 1978-79 academic year. Indicate by sex the number of departmental graduate student majors at the beginning and ending of the 1978-79 academic year (September 1 or thereabouts).

Beginning of Academic Year

	Male	Female	Total
Ph.D. graduate students			
M.S. on-campus graduate students			
M.S. off-campus graduate students			
Special students and other			
Total			

Ending of Academic Year

	Male	Female	Total
Ph.D. graduate students			
M.S. on-campus graduate students			
M.S. off-campus graduate students			
Special students and other			
Total			

4. Specialized areas of study (major-minor combinations) of M.S. and Ph.D. graduate students at beginning of academic year. All declared major-minor combinations are included.

	Off-campus M.S.	On-campus M.S.	Ph.D.	Special Other	Total
Agricultural Education					
Ag. Ed. and Ag. Extension					
Ag. Ed. and Agronomy					
Ag. Ed. and An. Science					
Ag. Ed. and Ag. Journalism					
Ag. Ed. and Ag. Mech.					
Ag. Ed. and Horticulture					
Ag. Ed. and Ag. Econ.					
Total					

5. Graduate degrees conferred. Indicate the number of M.S. and Ph.D. degrees conferred during 1978-79 academic year.

	Male	Female	Total
Number M.S.	______	______	______
Number Ph.D.	______	______	______
Total	______	______	______

6. Job placement of M.S. and Ph.D. graduates for 1978-79 academic year. Indicate the type of employment for 1978-79 advanced degree graduates.

	Off-campus M.S.	On-campus M.S.	Ph.D.	Total
Vocational ag. teaching (secondary)	______	______	______	______
Ag. teaching (post-secondary)	______	______	______	______
University	______	______	______	______
Graduate school	______	______	______	______
Agricultural extension	______	______	______	______
Agricultural business	______	______	______	______
Farming	______	______	______	______
Government agencies	______	______	______	______
Other	______	______	______	______
Total	______	______	______	______

7. Research efforts by staff or graduate students during 1978-79 academic year. List below the number of studies or research projects conducted or being conducted. Includes studies conducted by Exp. Station staff, for USOE, and other governmental units.

	No. studies
1. Agriculture and/or Ag. education in other countries	________
2. Agricultural extension (domestic and foreign)	________
3. Program and curriculum development	________
4. Evaluation including teacher evaluation	________
5. Guidance and counseling	________
6. Instructional materials/methods	________
7. Manpower-employment	________
8. Leadership development	________
9. In-service education	________
10. Teacher education	________
11. Administration	________
12. Adult/or young farmer education	________

8. Publication of research results. List below the number of publications released for publication and/or published during the 1978-79 academic year.

	No. publications
1. Referred journals	________
2. Non-referred journals	________
3. Departmental publication studies	________
4. Exp. Station bulletins	________
5. Popular articles	________
6. Papers presented at conferences	________

PART V. RESOURCE MANAGEMENT, ALTERNATIVES

1. Based upon your knowledge and observation, what proportion of your department's output comes from each of these functional areas?

_____% undergraduate teaching/advising
_____% graduate teaching/advising
_____% research
_____% in-service/extension
100 % total

2. Assuming that all functions are perfect substitutes, how would you alter the above product mix to achieve greater productivity from the department? (Circle increase, decrease, leave unchanged for each statement.) Assume no additional resources are available.

   a. I would increase, decrease, leave unchanged the undergraduate teaching and advising program resources.
   b. I would increase, decrease, leave unchanged the graduate teaching and advising program resources.
   c. I would increase, decrease, leave unchanged the research program resources.
   d. I would increase, decrease, leave unchanged the in-service and/or extension program resources.

3. Based upon your response to question #2, what proportion of departmental output should come from each of the major program areas after resources have been reallocated?

_____% undergraduate teaching/advising
_____% graduate teaching/advising
_____% research
_____% in-service/extension
100 % total

4. Assume that you had unlimited resources; staff, current expense, research funds, how would you alter the mix of departmental resources from its present status as shown in question #1? (Circle increase, decrease, leave unchanged for each statement.)

   a. I would increase, decrease, leave unchanged the resources used in the undergraduate teaching/advising program.
   b. I would increase, decrease, leave unchanged the resources used in the graduate teaching/advising program.
   c. I would increase, decrease, leave unchanged the resources used in the research program.
   d. I would increase, decrease, leave unchanged the resources used in the in-service and/or extension program.

5. Assume that you had unlimited resources as noted in question #4. What proportion of the total departmental output would you envision from each function?

_____% undergraduate teaching/advising
_____% graduate teaching/advising
_____% research
_____% in-service/extension
100 % total

1. Suppose you as department head could alter the quantity of undergraduate courses in agricultural edudation, check whether you would increase, decrease, or leave unchanged the number of courses in each of these areas:

Undergraduate Courses	Increase	Decrease	Unchanged
1. Introductory Course	______	______	______
2. Occupational Experience	______	______	______
3. FFA programs	______	______	______
4. Teacher preparation	______	______	______
5. Teacher supervision	______	______	______
6. Teaching methods	______	______	______
7. Curriculum development	______	______	______

2. Suppose you as department head could alter the quantity of graduate courses in agricultural education, check whether you would increase, decrease or leave unchanged the number of courses in each of these areas:

Graduate Courses	Increase	Decrease	Unchanged
1. Curriculum	______	______	______
2. Teaching methods/preparation	______	______	______
3. Philosophy/policy	______	______	______
4. Evaluation	______	______	______
5. Leadership	______	______	______
6. Guidance	______	______	______
7. Administrating Ag. Ed. program	______	______	______

3. How many credits equivalent of teaching do you consider to be a full-time load?

For departments on semester system, check appropriate answer:

______ 5 credits	______ 10 credits
______ 6 credits	______ 11 credits
______ 7 credits	______ 12 credits
______ 8 credits	______ more than 12 credits
______ 9 credits	

For departments on quarter system, check appropriate answer:

______ 5 credits	______ 10 credits
______ 6 credits	______ 11 credits
______ 7 credits	______ 12 credits
______ 8 credits	______ more than 12 credits
______ 9 credits	

4. Briefly describe how your department calculates work load or full-time equivalent. Include any formulas that are used.

Respond to each statement indicating your feelings ranging from strongly disagree to strongly agree.

	Strongly Disagree 1	2	3	4	Strongly Agree 5
1. Departmental resources should be allocated so that the greatest concern is to maximize total output from the department.	1	2	3	4	5
2. Department resources should be allocated so that the greatest concern is for the staff and/or student.	1	2	3	4	5
3. Joint appointments (across two or more colleges) contribute more to the productivity of the department than appointments in a single college.	1	2	3	4	5
4. Split appointments (teaching/research; teaching/extension) contribute more to the overall productivity of the department than a single appointment (e.g. teaching only).	1	2	3	4	5
5. Staff members on split appointments (teaching/research, etc.) should remain on those appointments for the entire academic year rather than switching back and forth each quarter or semester; ie, teaching one semester followed by all research next semester.	1	2	3	4	5
6. Departmental resources should be directed towards more undergraduate ag. ed. courses that are "service courses" for students majoring in other curricula.	1	2	3	4	5
7. Departmental resources should be directed towards more ag. ed. graduate courses that are "service courses" for students majoring in other curricula.	1	2	3	4	5
8. Staff members in agricultural education can be most effective and provide a greater contribution to the total educational system if they have a specialty in technical agriculture in addition to their expertise in education.	1	2	3	4	5
9. Resources used for in-service education of secondary and post secondary teachers could be more effectively used if reallocated to in-service and professional training of university faculty members in the department.	1	2	3	4	5
10. Resources used for departmental research should be increased to improve the quantity and quality of "interdisciplinary" research with other technical agriculture departments.	1	2	3	4	5