1981

Comparison of Independent Study to Group Study Methods in Mississippi Basic Vocational Agriculture Programs.

James Sherrell McCully Jr
Louisiana State University and Agricultural & Mechanical College

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COMPARISON OF INDEPENDENT STUDY TO GROUP STUDY METHODS
IN MISSISSIPPI BASIC VOCATIONAL AGRICULTURE PROGRAMS

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Vocational Agricultural Education

by

James S. McCully, Jr.
B.S., Mississippi State University, 1972
M.S., Mississippi State University, 1975
August 1981
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Mr. Farrar Grisham  
Clarkdale High School

Mr. Clyde Risher  
Sebastopol High School

Mr. Norman Mitchell  
Vaiden High School

Mr. Don Harding  
Caledonia High School

Mr. Kermis Myrick  
Poplarville High School

Mr. Mike Loftin  
West Lincoln High School

Mr. C. F. Fugitt  
Morton High School

Mr. Albert Cole  
Louisville-Winston Vocational Center

Mr. Rodney Childress  
Water Valley High School

Mr. Ira Duke  
Raymond High School

Mr. Marshal Stevens  
Lucedale High School

Mr. Monte Ladner  
Carthage High School

Mr. John Moorman  
Grenada Vocational Center

Mr. P. E. Roberts  
West Lauderdale High School

Mr. Randal Coker  
Northeast Jones High School

Mr. Jimmy McMillan  
Decatur High School
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ABSTRACT

The purpose of this study was to compare the independent study method to the lecture-discussion method in Mississippi basic vocational agriculture classes. Student achievement, time spent in study, and student and teacher opinion were utilized as dependent variables. The pretest-posttest control group design was selected for the study.

Three units of instruction were compiled for use by the two treatment groups. A pretest and posttest were developed for each unit. Two student assignments were also developed to serve as measures of student achievement. A student and teacher opinionnaire utilizing the semantic differential method was administered to measure opinions. Additionally, a standardized reading test was given to provide a measure of reading ability.

Schools in the study were selected and assigned to treatment at random. One class of students in each school participated in the study. Nine schools containing a total of 175 students completed the independent study treatment. Seven schools containing 157 students completed the lecture-discussion treatment. In the control group, there were seven schools and a total of 123 students.

Data were analyzed by computer with the unit of analysis being the school mean. Descriptive statistics used in the study included means, standard deviations, and linear correlations. Inferential statistics chosen as appropriate for testing hypotheses included analysis of variance and Students t distribution.
In relation to student achievement as measured by posttests, no significant differences were detected between the two treatments on each of the three posttests. The lecture-discussion treatment produced posttest scores significantly higher than the control group scores on all three posttests. The independent study treatment yielded significantly higher scores on two of the posttests than the control treatment.

No significant difference between the two treatment groups was detected when the student assignment scores were analyzed.

The time spent in independent study of the units was significantly less for each unit than the time spent in lecture-discussion study.

No significant difference could be shown to exist in student and teacher opinion toward instructional method. Teachers and students in the independent study group did differ significantly in their opinions toward instructional content.
Chapter I

INTRODUCTION

In the sixty-three years which have followed the passage of the Smith-Hughes Act, the role and scope of vocational agriculture programs have steadily increased. In 1917 when federal aid was first extended to such programs, the major responsibility of the local vocational agriculture teacher was to train men and boys for farming and the work of the farm home. This duty required that a curriculum for the program be developed which was based upon the needs of the local community. Classes for youth and adults focused upon production agriculture practices which could improve not only farm efficiency but also the overall quality of rural life.

National legislation passed in the ensuing years and changes in the agriculture/agribusiness industry have broadened the role and scope of vocational agriculture. While employment in farming occupations declined because of a combination of economic conditions and increased technology, employment in the agribusiness occupations related to farming increased. Public Law 88-210, The Vocational Education Act of 1963, recognized these changes. The Act extended the scope of vocational agriculture to include "any occupation involving knowledge and skills in agricultural subjects" (50, Sec. 10). To the original occupational cluster of production agriculture, the United States Office of Education added seven other clusters associated with agribusiness and renewable natural resources occupations. These new areas included agricultural supplies and services, agricultural mechanics, agricultural products
(processing, inspection and marketing), renewable natural resources, forestry, horticulture, and other agricultural occupations not classified elsewhere.

Public Law 90-576, The Vocational Amendments of 1968, further expanded the role of vocational agriculture by requiring that provisions be made for handicapped and disadvantaged students. The Education for All Handicapped Children Act, Public Law 94-142, passed in 1975 and the Vocational Amendments of 1976, Public Law 94-482, called for the possible inclusion of handicapped students in regular vocational agriculture classes. The 1976 Amendments also called for elimination of sex stereotyping in all programs.

As a result of this expansion of the role and scope of vocational agriculture, teachers now faced a two-fold dilemma not presented to earlier teachers. The first part of this dilemma was that their students were allowed to pursue a wide range of occupational objectives related to many agricultural jobs. Programs could no longer be solely based upon local farming enterprises. Provisions for agribusiness and renewable natural resources occupations were to be included. The second part of this dilemma was that teachers must provide instruction to a group of students with an everwidening diversity of needs, interests, abilities, and backgrounds. Classes were no longer composed entirely of boys from farm backgrounds, but contained males and females, handicapped persons, and urban and suburban students with little to no background in agriculture. In short, vocational agriculture teachers had to plan programs to meet the needs of any person desiring to enter any agricultural occupation. The only limitations placed upon enrollment were that the student must be interested in an agricultural occupation, able to enter
and succeed in that occupation, and able to benefit from the program.

With this expansion of the role and scope of the program, the responsibilities of state agencies in compiling curriculum and instructional materials have increased. The development of a total program of instruction to meet the needs of students with a wide range of goals and abilities was no longer possible for most teachers. Curriculum specialists housed in curriculum laboratories, teacher education departments, and state departments of education have now assumed more of this responsibility. Options were usually provided to allow teachers to adapt the produced materials to meet the needs of their local situation.

Format and content of these materials varied from state to state. Some states produced curriculum guides which contained a topical outline of instruction, suggested teaching activities, general objectives, and references. Other states developed self-contained guides which presented the necessary informational content for teaching. Efforts of all curriculum developers, however, have been directed toward the goal of helping the local teacher to plan and implement courses and curriculums designed to meet the needs, interests, and abilities of all students.

One teaching method which has received attention as a means of accomplishing this goal is individualization of instruction through independent study. This concept was seen by a number of leaders in vocational education as being a vehicle to deal with the two-fold problem of wide ranging occupational goals and student abilities found in many classes (24) (25) (27) (28) (29). To a certain extent this concept has been used by vocational agricultural teachers for years through supervised occupational experience programs outside of the school and through supervised study periods during class.
The Problem

Statement of the Problem

This study made a comparison between an individualized instruction method (independent study) and a group instruction method (lecture-discussion) in performance-based basic vocational agriculture programs in Mississippi. Stated in question form, the problem investigated was, "Can independent study modules be utilized as effectively as the group instruction process by typical high school students in Mississippi basic vocational agriculture programs?" A further comparison was made between the two treatments and no treatment.

The need for such a study was imperative. Many states, including Mississippi, have adopted a four-year plan for secondary level vocational agriculture programs. Under this plan, the first two years of coursework would be devoted to basic principles, skills, and knowledge related to all major agricultural occupations clusters. The last two years would then be directed toward specialized study in one of these clusters. A basic fallacy of this plan is that no common core of skills and knowledge related to all of the clusters can be determined. As a result of this fallacy, students in basic vocational agriculture programs who pursue occupational goals in horticulture and forestry, for example, must study units on animal science for at least part of the year. If the independent study method can be shown to be as effective as traditional group study, then increased program efficiency and effectiveness could be expected. Teachers could continue to provide group instruction to the majority of the class while students with differing occupational goals could study topics more closely related to their interests.
Purpose of the Study

The overall purpose of this study was to compare an individualized instructional method (independent study) to a traditional instruction method (the lecture-discussion technique) in terms of student achievement on unit tests and assignments and in terms of time spent in studying instructional units. It was thought that information gained from this study could influence the effectiveness and efficiency of basic vocational agriculture by allowing students greater flexibility in selection of learning content of courses.

Specific objectives of the study were:

1. To develop three individualized instruction units (modules) from existing group instruction units for basic vocational agriculture courses.

2. To compare the effectiveness and efficiency of the individualized modules to the group units in terms of student achievement on posttests and assignments and time required to complete the units.

3. To evaluate teacher and student opinion toward the content of the units and the two methods of instruction.

Hypotheses

Specific hypotheses which were formulated for this study were:

1. There is no significant difference in student achievement as measured by posttests among the independent study group, the lecture discussion group, and the control (no treatment) group.

2. There is no significant difference in student achievement as measured by student assignments administered to the independent study and lecture-discussion treatment groups.

3. There is no significant difference in the amount of time
required to complete the independent study and lecture-discussion units.

4. There is no significant difference of opinions among the following four groups concerning the content and methodology of the instructional units and treatments: (a) teachers in the independent study treatment group, (b) students in the independent study treatment group, (c) teachers in the lecture-discussion treatment group, and (d) students in the lecture-discussion treatment group.

Limitations

This study was limited to a sample of the population of schools in the state of Mississippi which taught the course, Basic Vocational Agriculture I, during the 1980-81 school year. This sample was confined to 23 schools or approximately 13 percent of the total population (179). A further limitation of this study was that the teachers at the selected schools had to be willing to follow the prescribed procedures for administering the materials provided to them.

Assumptions

Several important assumptions were made related to this study. These were:

1. It was assumed that the teachers in the study taught the units using standardized procedures.

2. It was assumed that within any given class of basic vocational agriculture students, a variety of student interests, abilities and goals could be found.

3. It was assumed that students in vocational agriculture programs were enrolled because of an interest in acquiring knowledge and skills related to agriculture/agribusiness.
4. It was assumed that the general reading ability of a student would strongly affect the ability of that student to utilize independent study materials.

5. It was assumed that a pretest on an instructional unit would serve as a predictor of student knowledge about the content of that unit.

**Definition of Terms**

1. **Analysis of covariance.** A form of data analysis which tests significance of the differences in two or more means by taking into account the correlation between the dependent variable and one or more covariates and adjusts the initial means to allow for the effect of the covariates (13, 370).

2. **Analysis of variance.** A statistical procedure which tests the significance of the differences in the means of two or more dependent variables by comparing variance among groups to the variance between groups (13, 216).

3. **Antecedent variable.** A variable which logically or casually existed prior to the administration of the treatment (22, 304).

4. **Basic vocational agriculture program.** A course or courses within the total vocational agriculture program designed to teach basic skills and knowledge which are related to many agricultural occupations to freshmen and sophomore high school students.

5. **Covariable.** A variable used in the analysis of covariance which contributes to the variance of the dependent variable and whose effect on the dependent variable is desired to be removed (7, 307-308).

6. **Dependent variable.** The outcome variable in an experiment
or the presumed effect of the experiment (22, 226).

7. **Independent study.** A method for individualizing instruction in which the student studies materials at a pace suited to his or her own ability (34, 10).

8. **Independent variable.** The manipulated effect in an experiment (22, 226).

9. **Individualized instruction.** A method involving student and teacher in establishing the pace, learning strategies, and instructional objectives that will provide the student with the incentive to self-master the skills, concepts, and values required for successful completion of a program (9, 13).

10. **Performance based education.** A program of education in which behavioral objectives based upon identified competencies serve as a guide for and evaluation of student learning (2, 276).

11. **Semantic differential.** A method for observing and measuring the psychological meaning of concepts involving the use of a series of bipolar adjectives and a seven point scale of agreement as the measuring device (13, 566).

12. **Terminal objective.** A behavioral objective which specified the performance required of a student upon completion of a unit of instruction.

13. **Unit of instruction.** The methods, content, activities, and assignments required to teach a terminal objective to a student (8, 225).
A search for available literature related to the basic vocational agriculture program and the independent study concept yielded many references which aided in the design and implementation of this study. Numerous professional journal articles, publications, textbooks, and research studies were used to form the framework of this research.

The following objectives were observed in conducting this review of related literature: (1) to acquire knowledge of similar research, (2) to discover ideas and suggestions concerning the development and implementation of independent study materials, (3) to discover ideas and suggestions concerning the design of the study, and (4) to compare the findings of this study with earlier studies.

In preparing this review, selected literature related to the study was categorized into the following major divisions: (1) Concepts of Basic Vocational Agriculture, (2) Concepts of Independent Study and Individualized Instruction, (3) Current Independent Study Formats, (4) Research Studies Related to Independent Study in Vocational Agriculture Programs, and (5) Other Related Research Studies.

Concepts of Basic Vocational Agriculture

The concept of a course in basic vocational agriculture began to evolve in the 1960s. As employment levels in farming and ranching declined, the need for expansion of vocational agricultural programs into
off-farm occupational areas became evident. The Vocational Education Act of 1963 provided funding which could be utilized for "vocational education in any occupation involving knowledge and skills in agricultural subjects, whether or not such occupation involves the work of the farm or of the farm home." (50, Sec. 10). This clause provided the legal foundation necessary to enlarge the scope of vocational agriculture to include agribusiness and natural resources occupations.

The Vocational Education Amendments of 1968 further broadened the scope of vocational agriculture to include new groups of persons to be served. In discussing the implications of this legislation, Taylor (32, 12-15) called for the creation of a systems approach to an articulated multi-level program extending from grade school through terminal degree. He stated that this program should be based upon the modular instructional package to permit open entry-open exit courses allowing individuals to progress at their own rates.

Thompson suggested a change in the traditional curriculum from successive production agriculture courses to a one- to two-year basic course followed by specialized courses in specific occupational areas (28, 17).

By the early 1970s such a transition in the curriculum was not only visible but specifically endorsed by leaders in the profession. At a 1971 national conference attended by agricultural educators from throughout the country, specific objectives and recommended steps of action were developed and published (35, 9-13). In relation to the basic vocational agriculture program the following specific action step was recommended: "provide organized instruction and supervised occupational experience in basic plant and animal production, basic agricultural
mechanics, basic leadership, and personal development to all ninth and tenth grade students electing such instruction, both urban and rural."
The basic vocational agriculture program was therefore designed to provide a foundation of skills and knowledge necessary for students to enter specialized programs in the junior and senior secondary grades and in post-secondary institutions. These programs were to be established in seven specific occupational clusters including production agriculture, agricultural supplies and services, agricultural mechanics, agricultural marketing, ornamental horticulture, forestry, and agricultural resources.

Mississippi introduced this program concept in 1972 (49). A series of curriculum guides was developed by a committee composed of teacher educators, teachers, and state supervisory staff members. These guides consisted of course outlines and suggested references for each of seven occupational clusters and for basic vocational agriculture. Major objectives of the basic course(s) were listed as being:

1. To develop the competencies in basic agriculture that are required for entering advanced or specialized courses in agricultural subjects.

2. To develop leadership abilities needed for success in agricultural occupations.

3. To develop an understanding of the occupational opportunities available in agriculture and the requirements for employment in such occupations.

An increasing emphasis on competency-based instruction led to a major research project by McCracken and Yoder (42). The foremost objective of this study was to identify a common core of skills (competencies) for the basic vocational agriculture course. The core
would consist of skills and knowledge related to all seven occupational areas. The researchers developed task inventories for twenty-eight representative agricultural occupations. These instruments were validated by incumbent workers and the data were analyzed by computer. While forty-eight common tasks were identified, most were of a non-agricultural nature. The authors concluded that the commonality and importance of task ratings might not be always directly related. They did recommend that tasks from a wide range of occupations should be included in basic vocational agriculture courses.

Amberson (23, 4-5) reported that a number of states had designed and recommended one- or two-year competency-based core curriculums for basic vocational agriculture courses. Such courses were taught to all students planning to enter specialized classes in the upper grade levels of high school. Subject matter content areas which were usually included in these basic courses were: (1) leadership, (2) occupational experience, (3) career orientation, (4) plant science skills and knowledge, (5) animal science skills and knowledge, and (6) agricultural mechanization.

Concepts of Independent Study and Individualized Instruction

Vocational agriculture teachers have always believed in some of the concepts of independent study and individualized instruction. Teske (9:15-16) reported that Stimson introduced the "project method" to vocational agriculture in 1905 and Field developed the "Integrated Course of Study" during the 1910s. McMillan (30:171) observed that Mississippi was credited as being the first state to center the program on the individual student by focusing the curriculum on his or her needs.
The concept of supervised or directed study was encouraged by many educators during the 1950s and 1960s. Drawbaugh and Hull (5:122-124) reported that this practice was widely used by many instructors. Various reference materials such as experiment station reports, magazines, textbooks, pamphlets, and other publications were provided to the students. Each student was then directed to study these materials independently. This practice was recommended as a method for introducing instructional units which were unfamiliar to the students and as a means for dealing with individual differences in student ability and interests.

Phipps (19:94-97) believed that such supervised study was important because it taught students how to study, evaluate materials, locate answers to other problems, and make decisions. He conceded, however, that without adequate reference materials and teacher supervision, supervised study periods might be of little constructive value.

The Mississippi State Department of Education (46) suggested that at least 45 periods each year be devoted to supervised studies related to the supervised training program of the student. Such study would be largely individual in nature since no student's training program would be identical to another's. This recommendation was made in an undated handbook used in the 1960s. It was interesting to note that the curriculum guide (49:30) developed in 1972 did not contain this recommendation.

Miller (31:205, 207) discussed the concept of independent study from the viewpoint of benefitting students whose occupational goals differed from the majority of the class. Such students would be allowed to complete a written report or special project such as a bulletin board display, radio script or newspaper article related to their objective.
The concepts of individualized education have been discussed by a multitude of authors including Pucel and Knaak (20), Finch and Crunkilton (8), Talmage (21), Charles (3), Duane (6), and Frantz (9). Many commonalities and some differences were noted in the individual author's concept.

Scott (4, 106-107) observed that individualized instruction was not synonymous to terms such as programmed instruction, independent study or tutorial approaches. These methods might serve as a component of an individualized instruction system but in themselves did not consist of such a system. The following concepts of an individualized instruction system were summarized:

1. The system would be student centered.
2. Content of the system would be based upon the occupational goal of the individual student.
3. The system would provide for frequent student-teacher contact to insure that learning objectives were being met.
4. A wide variety of teaching strategies and media would be fitted to the needs and abilities of each student.
5. The system would be flexible in terms of time and student goals.

Finch and Crunkilton (8:222-223) stated that the concept of an individualized education program was composed of five components: the student, instructional environments, instructional strategies, instructional media, and instructional content. All five components must be used simultaneously and in concert, with the student being the central component.
Teske (9, 14) wrote that an instructional system, plan or unit could be said to be individualized when:

1. The characteristics of the student played a major role in the development of the system, plan, or unit.
2. Student progress was measured in terms of accomplishment of objectives.
3. Teacher activity was devoted to the individual student rather than the group as a whole.
4. Each student had a personal plan of instruction.

In examining the role of the teacher in an individualized instruction program, Law (12, 167-173) made several interesting comments. The effectiveness of the program was based upon the teacher's attitude rather than a specific teaching style. Human contact between teacher and student was essential. Teachers had to realize that their role was not one of active direct information giving but one of quiet support, sharing the direction of learning content with the students. Individual learning required a variety of teaching materials and methods, but it could be accomplished without the need for the latest commercial equipment and technologies. Individualized instruction programs were most successful when the teacher had a genuine concern for providing each student with an optimum educational experience.

Baker and Goldberg (6:62-64) clearly stated that individualized education and independent study were different concepts. Individualized education was more structured than independent study while at the same time very flexible. A wide variety of teaching methods and materials were employed in individualized programs in addition to independent study.
The Georgia State Department of Education (38:1-4) developed a manual for installing and operating an individualized instruction program. This publication listed three predominant characteristics of individualized programs as being open entry of students, individual pacing, and completion when stated objectives were met. Special emphasis was placed on the concept of individual pacing as compared to self-pacing. Eight advantages of such a program were described as follows:

1. Learning by objectives.
2. Frequent feedback between instructor and student.
3. Unit perfection required.
4. Students progress at their best learning rate.
5. Individual course prescriptions possible.
6. Flexibility in training approaches.
7. Instructors could spend more time with students needing help.
8. Less of each type of equipment is needed.

The Alabama State Department of Education (34, 9-12) identified eight different levels of individualization. These were:

1. **Self study.** This level involved individual study by students at a group rate. All students were allowed the same amount of time to study the same material. This method was recommended when learning objectives were largely supported by group activities.

2. **Rate of progress.** This level was similar to self study but each student was allowed to study at his or her optimum rate. Supporting exercises or activities are also conducted at an individual pace. (Note: This level corresponded to the level used by the author in the present study.)
3. **Mode of learning.** Elements of the two previous levels were present. Additionally, students were allowed to use different materials or activities to accomplish lesson objectives.

4. **Student learning needs.** Content of the course of program was individualized by student. Instruction was provided only when students could not demonstrate mastery of lesson objectives. This level was also termed individually prescribed instruction.

5. **Learning difficulty.** This level involved designing a course of varying levels of difficulty, based upon student ability. Levels 1-4 might be included at varying degrees in this level.

6. **Direction.** This level was divided into two sub-levels. Course-direction design was based upon objectives established by the course itself and was the most common design used in vocational courses. Self-directed courses allowed students to "contract" or select objectives they were to achieve.

7. **Environmental or instructional setting.** This level allowed individualization of where the student would accomplish the learning activities. In some cases this might be a school setting; in other cases, a home or business setting might be selected.

8. **Independent study.** At this level, students were provided a list of objectives and general guidelines for meeting these objectives. They then were allowed to select their own materials and activities for meeting these objectives and to set their own timetables for doing so. Periodic reports to an instructor or monitor were required.

The manual noted that many specific individualized education programs included several of these levels.
Current Independent Study Formats

Materials for use as independent study units in individualized instruction programs have been produced by a profusion of sources including local school districts, state departments of education, university curriculum centers, and commercial publishing companies. These materials range from mimeographed student handouts to hardbound texts, to audiovisual media, or combinations of these packages. In general, most formats centered on a set of performance objectives and the means and content material necessary to meet these objectives. Some type of measurement device was also included. Some of the more common formats for independent study units were researched and reported on.

Smith (11, 24) described the Learning Activity Package or LAP as "a form of communication between the student and the teacher that contains instructions for student activities leading toward specified performance outcomes." Major components of a LAP were: (1) title, (2) rationale - an introduction to the unit, (3) prerequisite knowledge - self assessment instruction - a self test to see if the student had already mastered prerequisite skills and knowledge, (4) objectives - to guide or structure the behavior of the learner, (5) self-evaluation - a pretest on the objectives, (6) special student directions or general classroom management procedures - to guide student and/or teachers, (7) learning activities - the core of the package - a series of activities appropriate to meeting the objectives, and (8) teacher's instructions - special material to assist the teacher in administering the LAP including a posttest.

Klingstedt (1, 61-67) discussed a general format for a learning module (LM) to be used in competency-based individualized programs. The
first component of a learning module was objectives stated in performance terms. The second component was a pretest to determine if the student needed to proceed through that individual module. The third major part was a rationale to establish the value of the module. This was followed by component four, the learning alternatives. These alternatives allowed teachers and learners to select various methods for meeting the stated objectives. Part five, a posttest, measured the learner's achievement of the objectives. The final section, resources, included a listing of all needed materials, media, and readings.

Scott (4, 109) listed six essential components of a vocational learning package (VLP). The first component was a guide sheet which served as a direction setting device including what is to be learned and why. The second essential component, evaluation, provided provisions for a pretest, student self test, instructor checks, and posttest. A third section, instructional sheets, served to support and clarify learning activities. Job sheets, the fourth component, provided a step-by-step procedure for activities. A resource list of written materials and a media list of audio-visual materials composed the fifth and sixth sections.

A typical format for individual, competency-based modules was outlined by Finch and Crunkilton (8, 231). This format included six major sections including (1) introduction, (2) objectives, (3) preassessment, (4) learning experiences, (5) resource materials, and (6) postassessment. Five important characteristics of competency-based modules were discussed. First, such modules should be self-contained so that the student would not have to search for materials to use. Second, the module should be typically individualized allowing for self-pacing,
feedback, and mastery. The third characteristic was completeness. The module should reflect a logical and systematic flow of content. As a fourth characteristic, each module should include objectives and learning experiences to help the student meet these objectives. Finally, a module should have some mechanism for assessing student performance.

The State of Alabama developed a format for individualized modules for student use with a separate format for teacher guides. The student units (34, 29-57) contained an introduction, objective(s), directions for pretest (if used), materials, information lesson, application, and evaluation. The teacher guide also contained an introduction and objective(s). In addition, however, this publication also included sections on materials and equipment needed, directions for administration, and other items such as answer keys to pre- and posttests, copies of these tests, and other criteria for evaluation.

Kentucky used a similar format for developing modules for use in tractor mechanics programs (26, 202-203). Each module was composed of an introduction, directions, objectives, learning activities, instruction sheets, student self checks, check out activities, and an instructor's final checklist.

Research Studies Related to Independent Study in Vocational Agriculture Programs

In comparison to other areas of vocational and general education, few studies concerning the effectiveness of independent study in vocational agriculture could be located. Those which were reviewed, however, proved to be of great assistance in the design and implementation of this study.
Otto (48) conducted a study to determine the effectiveness of programmed instruction versus the lecture-discussion method. A total of 480 students in twenty schools spread through five states were used as subjects. Eight students were selected from each of the following levels: (1) basic agriculture, (2) advanced agriculture, and (3) young and adult farmers. Four students were taught by programmed instruction and the other four by lecture discussion. A pretest and reading test were used to control individual differences. The study found the lecture-discussion method to be significantly better than programmed instruction.

McCarley (31) investigated the effectiveness of independent study as compared to the lecture-discussion method. Four Michigan high schools were selected involving 138 junior and senior level students. Two classes were used at each school with one class being taught by each method. A pretest-posttest design was employed. An interest inventory and temperament survey were also employed. Students who completed the individualized treatment were asked to complete an evaluation instrument. McCarley found the independent study method to be significantly better than the lecture-discussion approach. He also concluded that the students in the study acquired more skills and knowledge by using a combination of psychomotor and cognitive learning activities and by using cognitive activities alone. Agricultural interest was related to achievement when an assignment required a combination of psychomotor and cognitive activities. A correlation between academic rank and achievement was found to exist only if mathematical skill was involved. Finally, student opinion toward independent study clustered toward the favorable end of the scale.
A similar study was conducted by Oen (47). This study involved twenty-nine schools assigned at random to three treatment groups: independent study, lecture discussion, and control. Five antecedent tests were administered before treatment began. A battery of posttests was given at the conclusion. In all there were six antecedent variables and seven posttests. The school mean was used as the dependent variable. Data were analyzed using univariate and multivariate analyses of variance and covariance. The two treatment groups were shown to be significantly different from the control group. When each of the six antecedent variables was considered individually, the independent study method was significantly better than the traditional lecture discussion technique. When all six were combined in one procedure, no significant difference was detected.

Other Research Studies

A multitude of studies related to individualized education and independent study have been conducted in the other vocational service areas and in academic education projects. Impellitteri and Finch (40, 17) reported that literally thousands of studies have been directed to evaluate the difference between two instructional methods. Hinton (39) offered the following generalizations on the findings of this research:

1. Individualized instruction systems worked at least as well as traditional methods and in some cases were significantly better.

2. Withdrawal rates were equivalent for individualized and traditional methods.

3. Student attitudes were favorable toward individualized instruction.
4. The use of learning objectives produced significant increases in learning.

5. The use of proctors improved the rate of student learning.

6. Test anxiety and grade pressure were reduced.

The Interstate Distributive Education Curriculum Consortium (IDECC) has developed and validated 500 competency-based learning activity packages related to Distributive Education (4). The Consortium was composed of twenty-three member states. Each learning activity package was designed to be used individually, in a small group setting, or with a class size group. Under the IDECC system, teacher and student identified an occupational objective. Occupational objectives for all students in the class were then processed by computer. The computer then identified which of the 500 LAPs were needed by each student to reach his or her objective. A common list of competencies for all class members was then identified. Other competencies related to small groups of students were also determined. Finally a list of competencies peculiar to individual students was compiled. A teacher could then plan a totally individualized instruction program for the class based upon the large group, small group, and independent study.
Proper design and methodology are essential in any experimental study. The procedures employed in conducting this study are discussed in this chapter. The major steps followed in conducting this experiment were: (1) Design of the study, (2) Development of the materials, (3) Development of the instruments, (4) Selection of the standardized reading test, (5) Selection of the sample, (6) Training of the teachers in the sample, (7) Field testing of the instruments and materials, (8) Final preparation of materials and instruments, (9) Collection of the data, and (10) Analysis of the data.

Design of the Study

This study utilized the randomized control-group pretest-posttest design as reported by Van Dalen (22, 247-252). The design was summarized as follows:

Group 1  \[ R' \ T_1 \ T_2 \ X_1 \ T_3 \ T_4 \ X_2 \ T_5 \ T_6 \ X_3 \ T_7 \ T_8 \]

Group 2  \[ R' \ T_1 \ T_2 \ X_4 \ T_3 \ T_4 \ X_5 \ T_5 \ T_6 \ X_6 \ T_7 \ T_8 \]

Group 3  \[ R' \ T_1 \ T_2 \ T_3 \ T_4 \ T_5 \ T_6 \ T_7 \]

In this design, schools were selected and assigned to treatment groups at random (R'). Three units of instruction were taught to the students in Group 1 using the independent study method (X₁, X₂, X₃). The same three units were taught to Group 2 using a traditional lecture-discussion approach (X₄, X₅, X₆). A standardized reading test (T₁) was administered,
as were unit pretests for each of the three units (T₂, T₄, T₆). Finally unit posttests and student assignments (T₃, T₅, T₇) were given to serve as measures of achievement. After all instruction was completed, students and teachers in Group 1 and Group 2 were asked to complete an opinionnaire (T₈) related to content and methodology of the materials. The unit of analysis was the school mean.

**Development of the Materials**

Instructional materials used in this study were developed by the researcher as part of his duties with the Mississippi Research and Curriculum Unit for Vocational and Technical Education (R/CU). Rough drafts of the units selected for this study had already been prepared and awaited only nominal revision prior to the beginning of the study. Materials for the lecture discussion treatment group were adapted from the independent study materials.

Work on a new curriculum for basic vocational agriculture courses was begun by the researcher in 1977. A clear need was felt at that time for new directions in program emphasis. Existing materials were inadequate in content, scattered throughout several existing publications, and in some instances, out-of-date. A decision was made to develop new materials which would be performance-based, content complete teacher guides. The researcher was assigned this project. Content outlines and sample material formats were prepared and submitted to leaders in the field. After meeting with teachers, teacher educators, and state staff personnel, a final outline and format was agreed upon.

The final outline was composed of five major sections which presented an introduction to the following topics: (1) vocational
agricultural education programs, (2) livestock production, (3) soil classification, measurement, and usage, (4) crop production, and (5) agricultural mechanics. Thirty-six units of instruction were compiled from these five major sections. A copy of the final outline is presented in Appendix A.

For use in this study, the researcher selected three units related to crop production and converted the rough drafts into independent study units. These units contained information related to an overview of significant crop enterprises in Mississippi, crop and seed selection techniques, and plant nutrients and fertilizer application. These units were selected because:

1. They contained a balance of cognitive and problem-solving activities.

2. No special teaching equipment or supplies were necessary to fully utilize these units in a controlled manner.

3. Some elements of each unit would apply to students with occupational objectives in areas such as production agriculture, horticulture, agricultural mechanics, agricultural supplies and services, and forestry.

In order to convert the rough draft group instruction units into independent study materials, several changes were made. While the basic format and content remained the same as in the rough drafts, names of the difference sections were changed to help personalize each unit. The first section of the unit, formerly the introduction, was renamed "What's Up?" This section contained a brief introduction to the subject and a rationale for studying the topic. The second section was entitled "Your Objective." In the place of simply listing performance objectives
in sequential order, an effort was made to personalize them. Rough draft objectives for each unit are listed in Appendix B.

Section III, "Meeting Your Objective," of each independent study unit corresponded to the learning procedures section of the rough drafts. This section provided step-by-step procedures for completing each unit. Specific instructions were given for completing student assignments and unit tests. The fourth section of each unit was entitled "FYI (For Your Information)". This section contained the content information necessary to accomplish the student objectives. Transparency masters used in the rough drafts of the units were included as figures in this section. A unit summary, entitled "Summing Up" was also compiled for each unit.

Section V of each independent study unit was entitled "How Much Have You Learned?" Various activities such as crossword puzzles, word completion games, and sample mathematical problems were included in this section to help reinforce the FYI materials. This was the only section of the independent study materials not previously found in some form in the rough drafts.

First drafts of the independent study materials were compiled and subjected to review by staff members of the R/CU and the Mississippi Agricultural and Forestry Experiment Station. Only minor revision for technical accuracy was required.

Development of the Instruments

The following instruments for measuring student achievement were developed by the researcher for use in this study: three unit pretests, three unit posttests, two student assignments, and one opinionnaire for use by both teachers and students in the treatment groups.
The unit pretests and posttests consisted of a total of twenty items. Ten items were true-false type questions and ten were multiple choice with four possible answers. True-false and multiple-choice questions were selected to aid in control of the grading process. Concepts tested by all items were taken from the objectives of each unit. To avoid some possible effects of the pretests, the format for each item was reversed from pretest to posttest. If a concept was tested by a true-false question on the pretest, then the same concept was tested as a multiple-choice question on the posttest. Drafts of the pretests and posttests were reviewed by research specialists in the Research and Curriculum Unit and the Mississippi State University College of Education.

Two student assignments were developed to measure problem-solving skills related to the content of two of the instructional units. The first assignment which related to the unit on plant selection provided the student with two hypothetical situations. In the first situation the student was asked to select the best variety of soybeans under the given conditions. The student was asked to then identify at least two reasons for making this choice. Pertinent information for making a decision was supplied. In the second situation the student was asked to mathematically calculate the most economical source of seed given the price and quality levels of two different sources.

The second student assignment related to the unit on plant nutrients and fertilizers. The study was given a situation in which the true cost of three different sources of nitrogen had to be determined. All necessary information was provided on the assignment sheet.

In order to measure both student and teacher opinion toward the methodology and content of the materials, an opinionnaire was constructed
using the semantic differential technique developed by Osgood, Suci, and Tannenbaum (17). Measurement of these two concepts was achieved by using nine pairs of bipolar adjectives. Respondents were asked to check how closely their feelings toward each concept were to one or the other adjectives using a seven point scale. Adjective pairs were selected from lists prepared by Osgood, Suci, and Tannenbaum (17, 53-61) and from the researcher's imagination. In addition to the two semantic differentials, student instruments asked for personal data about the student such as occupational goal and overall grade average. Teacher instruments asked for years of teaching experience, type of certificate held, and size of school. Specific instructions for using the semantic differential were included on each instrument. The meanings of the two concepts being measured were also specified.

Selection of the Standardized Reading Test

Reading ability of the students was expected to correlate with the students' scores on the unit posttests. It was proposed, therefore, to administer a standardized reading test to all students involved in the study. After consultation with reading specialists in the College of Education, the California Achievement Test, Book 18C, Reading was selected (36). The test consisted of two major sections. Section 1 tested student vocabulary knowledge levels using thirty items. Section 2 tested student reading comprehension using forty items. The CAT Level 18 was selected over other existing tests because:

1. It was considered fairly simple to administer in a controlled manner.
2. The time required to administer the test was less than 55 minutes.

The developers of this test reported a reliability coefficient of .94 at grade level 9.2. This coefficient was computed using the Kuder-Richardson Formula 20 (37, 81).

Selection of the Sample

As previously discussed, the sample used in this study was selected and assigned at random to one of the three treatment groups. A list of all schools teaching vocational agriculture in Mississippi was secured from the Mississippi State Department of Education. Each school was assigned a three-digit number. Area vocational schools which were known to teach only specialized vocational agriculture courses at the junior and senior class level were not assigned a number. There were a total of 179 schools teaching vocational agriculture during the 1980-81 school year.

Using a table of random numbers (10, 92-97) thirty schools were selected and assigned to treatment groups. A random sequence of assignment was determined so that the first school drawn was assigned to Group 1, the second school to Group 3, and the third school to Group 2. This sequence of assignment was continued until ten schools were assigned to each group.

An initial contact letter explaining the purpose, objectives, and general procedures of the study was prepared and mailed to a vocational agriculture teacher at each school. The letter stated that the school had been selected at random and that the teacher was being asked to participate in the study. It clearly outlined that each teacher
would be expected to follow the established procedures of the study. Teachers in the two treatment groups were told that it would take from three to five weeks to administer the materials. In cases where two or more teachers were teaching vocational agriculture in the same school, the letter instructed the teacher who received it to pass it and the accompanying materials to the teacher who was teaching Basic Vocational Agriculture I.

A self-addressed, stamped postcard was enclosed with the letter. Teachers were asked to reach a decision and inform the researcher as soon as possible. They were told that if they felt they did not have time to participate in the study, then they should respond by saying "No."

Of the thirty original schools in the sample, seven teachers were unwilling or unable to participate in the study. Two of these teachers simply refused to participate without providing any explanation. The other teachers did not participate because they were retiring from teaching, not teaching basic agriculture that year, or moving to another school. Seven new participants were then selected using randomized procedures and were mailed initial contact letters. Three of these teachers responded favorably.

By the closing date of the self-imposed deadline for selecting the sample, nine teachers had agreed to teach by the independent study method; nine teachers had agreed to teaching using the lecture-discussion method, and eight teachers had agreed to serve as a control group. The total number of schools involved in the study at its beginning was twenty-six.

At the end of the data collection period, two teachers in the lecture-discussion group reported that they were unable to complete
instruction because of intervening circumstances. One teacher in the control group did not administer the pretests and posttests according to directions. These three schools were, therefore, deleted from the study, reducing the number of schools in the study to twenty-three. The locations of these schools are shown in Figure 1.

Training of the Teachers in the Sample

Prior to the administration of the treatments and collection of the data, a training session was held for all teachers participating in the study. The major objectives of this session for the control group teachers were:

1. To familiarize these participants with the total study and their role in the study, and
2. To inform them of the different instruments to be administered and the standardized procedures for their administration.

The major objectives of the session for the group instruction treatment participants included Objectives 1 and 2 above and the following:

3. To inform these participants of the content and methodology of the materials, and
4. To inform them of the actual procedures to be followed in teaching these materials.

For teachers in the independent study treatment group, objectives of the training session included those listed above, and

5. To inform these participants of the concepts and basic teacher role in independent study.

A summary of the presentation to the participants was prepared and presented to those teachers at the meeting. Teachers who had agreed to
Figure 1

Location of Schools in the Sample
participate in the study, but were unable to attend the training session, were mailed a copy of this summary.

**Field Testing of Materials and Instruments**

The initial drafts of the three independent study units and their accompanying pretests and posttests were field tested prior to final preparation. A school outside the sample was selected for the field testing. The researcher prepared copies of the materials and instruments and traveled to this school to administer them personally. Three classes of basic vocational agriculture students were assigned to the researcher. Each class completed one unit following procedures that would be used in the main study. Results of the field test data were summarized in Table 1.

**Table 1**

Summary of Field Test Data

<table>
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<th>Unit Number</th>
<th>Pretest</th>
<th>Posttest</th>
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</thead>
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<td></td>
<td>( \bar{x} )</td>
<td>( s )</td>
<td>( \bar{x} )</td>
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<td>1</td>
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<td>2.775</td>
<td>14.222</td>
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<tr>
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<tr>
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<td>8.353</td>
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<td>11.412</td>
</tr>
</tbody>
</table>

A t-test to compare the difference in pretest and posttest scores was conducted on the data. Results of this statistical procedure were significant for each of the three units (alpha = .05).
Test reliability was calculated for each of the pretests and posttests using the split-halves technique and the Spearman-Brown prophecy formula (22, 139-140). Results of these calculations were reported in Table 2.

### Table 2
Reliability Coefficients for Pretests and Posttests

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<th>Unit Number</th>
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<th>Posttest r</th>
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</thead>
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<td>.9211</td>
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<tr>
<td>2</td>
<td>.3822</td>
<td>.4983</td>
</tr>
<tr>
<td>3</td>
<td>.3655</td>
<td>.7719</td>
</tr>
</tbody>
</table>

As indicated in Table 2, pretest reliability coefficients were lower than those of the posttests. Since the items on both tests evaluated the same concepts, it was assumed that the lower reliability on the pretest was at least partially a result of guessing on the part of the students. Mehrens and Lehman reported that the guessing of test questions can lower the test's reliability coefficient (14, 117).

The rough draft of the opinionnaire was also field tested on a group of students outside the sample. The researcher personally administered the instrument using procedures that would be followed in the study. Responses of the students in the field test group were tabulated by hand and a split half reliability coefficient corrected by the Spearman-Brown prophecy formula was calculated. This coefficient was determined to be .9401.
Final Preparation of Materials and Instruments

Upon completion of the review and field testing of the initial drafts of the materials and instruments, final revisions were made by the researcher. Only nominal revisions of the materials were deemed necessary. Each lesson was read and an attempt was made to further reduce the reading level of the materials. Procedures for performing the mathematical calculations in Units 2 and 3 were also simplified.

An attempt was made to improve test score reliability for the three pretests and the posttest for Unit 2. A simplified item analysis was conducted and several items on the tests were revised.

All materials and instruments were then submitted to the R/CU editor for editing. The final copies were then typed and proofread for errors. All materials were duplicated by offset lithography. Each unit of instruction was bound separately using a hot-glue process and a heavy-weight coverstock. Each unit was given a title and was designated a publication of the Research and Curriculum Unit (43) (44) (45). To facilitate use of the units and their pretests, student assignments, and posttests, a color code was developed. A different color of coverstock was used on each unit. Pretests, student assignments, and posttests were printed on paper of the same color as the unit cover. Copies of each pretest, posttest, student assignment, student opinionnaire and instructional unit are attached in Appendix C of this document.

User's manuals were prepared and published for the teachers in the independent study and lecture-discussion treatment groups. The manuals consisted of instructions and procedures for teaching the units; answer keys for pretests, student assignments, and posttests; and the
three units of instruction. Important points related to unit objectives and tests were underlined in the teacher's guides. Specific instructions for administering and grading the tests and student assignments were also included in these publications.

**Collection of the Data**

October 15, 1980 was the target date for the beginning of the collection of the data. Because of a delay caused by the printing process, materials and instruments were not shipped to the teachers until October 17. Student materials and tests were shipped by United Parcel Service. Teacher materials were mailed via first class mail through the U. S. Postal Service. Teachers were instructed to finish administering the units prior to the Christmas break. Teachers in the independent study group were able to meet this deadline. Some teachers in the lecture-discussion study group were unable to finish prior to the semester break and had to continue teaching until mid-January.

Because of time limitations and the expenses of purchasing sufficient quantities of the standardized reading test, this instrument was not administered to all schools prior to the beginning of treatment. Four sets of test booklets were ordered. The researcher prepared a detailed step-by-step procedure for administration. This procedure along with a cover letter, copies of the test, and answer sheets were mailed to the schools. Prior to the mailing of the first sets, the author carried the above items to a school in the sample and observed the teacher as he administered the test. This served as a check on the effectiveness of written procedures.

Copies of the reading test, answer sheets, and procedures for
administration were mailed to each school in a reusable container. Teachers were instructed to administer the test as soon as possible and then to return everything in the container. Self-addressed stamped return labels were supplied. Four schools administered the test at approximately the same time. As soon as a set was returned, it was mailed to another school until all schools in the study had been tested. In order to help control the effect of maturation of the students, a random order of treatment groups was established. This order was lecture-discussion group, independent study group, and control group. This sequencing caused the test to be administered evenly to all three groups over the time span. Administration of the reading tests began on October 8, 1980, and was completed by March 1, 1981.

Once the answer sheets were returned to the researcher, they were scored by hand stencil. A combination score on the vocabulary and reading comprehension tests was determined and recorded on a standardized form for coding computer data. Other information obtained from the reading test answer sheets included the student's grade in school, age, and sex. These were also recorded on the coding form by student name.

The general procedures for the administration of the treatment and collection of the data for the independent study group were:

1. The students were prepared for the treatment. It was suggested that approximately one-half hour be spent on informing the students about the procedures for using the materials. Students were to be told only that they would be using a new type of material.

2. The pretest was administered. Pretests were administered under the same conditions as posttests. Students were informed that the pretest was designed to see how much they already knew about the subject
to be studied. They were also told that the pretest would not count as a grade. Pretests were graded outside of the class period and each student's score was recorded on the grade report form provided. The pretests were not returned to the students.

3. The students completed the instructional unit. Each student was given a copy of the unit. They were instructed to read the entire unit and were encouraged to ask questions to the teacher about points they did not understand. They students were told to work at their own speed, but that they should not loaf. Teachers were instructed to be accessible to students at all times, and to actively circulate around the room. After reading the unit, the students were asked to complete the section entitled, "How Much Have You Learned?". Teachers were to check each student's answers against the master key and to mark any wrong answers. Wrong answers were to be corrected by the student and all answers were to be corrected before the student proceeded to the next step.

4. The student assignment was administered. When the student had demonstrated understanding of the unit content by correctly answering all items in the "How Much Have You Learned?" section of the unit, he or she could ask the teacher for the student assignment. (There was no student assignment for the first unit.) The assignment was considered an open-book test and students were allowed to use their units in completing it. Once issued to a student, the assignment was to be fully completed during that class period. The assignments were to be graded outside of class following specific grading procedures supplied. Grades were recorded on the grade report form.

5. The unit posttest was administered. The student could take
the unit posttest after completing the student assignment. (In the case of the first unit, the posttest was administered after the student completed the "How Much Have You Learned?" section of that unit.) The posttest was given under normal testing conditions. Students were to complete it on their own with no help from notes, the unit, or other students. The posttest had to be completed during the class period it was issued. Posttests were to be graded by the teacher outside of class. In addition to the twenty items on the posttest, the student was asked to record the approximate number of hours that had been spent in studying the unit, including the time it took to complete the two tests and assignments.

6. When the student completed the unit test for the first unit, the cycle of pretest, study, student assignment, and posttest was then completed for the second unit and for the third unit. When all units were completed, the teacher was instructed to return the grade report forms to the researcher and the data on these forms were transferred, by student name, to the computer coding sheets containing student age, sex, grade level in school, and reading test scores.

The general procedures for administering the lecture-discussion treatment were similar to the procedures for the independent study treatment. All pretests, posttests, and assignments were administered to the class as a group. Teachers followed a standardized procedure of introducing the unit, identifying lesson objectives, presenting lesson content, and then administering student assignments and the unit posttests. Teachers were told to actively involve the students in discussing lesson content whenever possible. Students were to make notes on important points in the units. These points were underlined in the teacher's guides.
Procedures for administering, scoring and reporting student grades on the tests and assignments were the same as for the independent study group. All tests and assignments were graded by the teacher. The students were allowed to consult their notes when completing the student assignments, but were not allowed to do so on the unit test. The section in each unit entitled "How Much Have You Learned?" was not used by students in this group.

Teachers in the control group were provided with copies of the three unit pretests and three unit posttests. Answer keys and grade report forms were also supplied. Students were to be informed only that they were participating in a study by Mississippi State University. All pretests were to be administered on the same day. The students were to be told to consider each item carefully and to select the best answer. They were not to be informed about the posttests which were given approximately one week later. Teachers were requested to grade the tests and record the scores on the grade report form.

Student and teacher opinionnaires were mailed on December 3, 1980. Teachers were instructed to administer the opinionnaires after all instruction was completed. Prior to having the students complete their instruments, the teachers were to read the instructions for completing the semantic differentials to the students. A self-addressed, postage-paid envelope was included for use in returning the opinionnaires. Only schools in the independent study and lecture-discussion treatments received the opinionnaires.

The rate of return on the opinionnaires was not optimum. Of the nine schools which completed the independent study treatment, seven returned the questionnaires. Of the seven schools which returned test
scores in the lecture-discussion group, only four returned questionnaires. Follow-up telephone calls to non-responding teachers revealed that they believed they had administered the questionnaires and mailed them. None of these questionnaires were received by the researcher, however.

Responses on the questionnaires which were received by the researcher were recorded on standard computer coding sheets for later analysis.

Analysis of the Data

As the grade report forms and reading test answer sheets were received from the schools in the study, the data were transferred to standard computer coding forms. When all data were received for each school, the students' names were removed from the coding sheets and replaced with a five-digit identification number, indicating treatment group, school, and individual identification of each student. Data for each student consisted of seven antecedent variables and eight dependent variables. The antecedent variables were sex, age, grade, reading test score, pretest 1 score, pretest 2 score, and pretest 3 score. Dependent variables were scores on the three unit posttests, scores on the two student assignments, and time spent studying each of the three units. No time values or student assignment scores were recorded for the control group.

Data for all students were transferred from the coding sheets to standard computer cards. The facilities of the Thomas E. Trammel Computing Center at Mississippi State University were utilized to analyze the data. The computer program SPSS (Statistical Package for the Social Sciences) (16) was used to perform the analysis.
Prior to the testing of the Hypotheses 1-3 of the study, a preliminary analysis of the raw data was performed. Since the dependent variable was the school and not the student, means for all antecedent (except sex) and dependent variables were computed. All means were rounded to the nearest two decimal places and then tabulated. A new set of data cards was then prepared consisting of the means of the twenty-three schools.

A series of preliminary data analyses was performed prior to the testing of the major hypotheses. Group means and a grand mean of all groups were calculated. Pearson's correlation coefficients were used to evaluate the relationship between the antecedent and dependent variables. The univariate analysis of variance technique was employed to determine if any differences in the three groups of the study could be found as measured by the antecedent variables. Finally a test reliability coefficient was calculated for each pretest and posttest using the Kuder-Richardson Formula 21 technique.

Based upon the information obtained from the preliminary data analyses, the analysis of variance technique was chosen as the appropriate procedure for testing Hypothesis 1. If a difference in the means of the three groups was detected by this test, then Scheffe's S method for multiple comparisons was selected as a post hoc test. Scheffe's S was described by Meyers (15, 363-364) as being the most conservative of the post hoc tests available. Also he noted that the Scheffe test was appropriate for groups of unequal size.

Hypotheses 2 and 3 of the study involved tests of differences in two means. For these tests, the Student's t procedure was selected.
For testing Hypothesis 4 of the study related to teacher and student opinion concerning instructional methods and content, the univariate analysis of variance was chosen as the testing procedure. Individual scores on each set of semantic differential scales were summed and a school mean calculated for the students and teacher at that school. These school means as classified by treatment were then subjected to the analysis of variance procedure. If a difference in the four means was detected, then the Scheffe's S method would be used to compare means and determine the extent of this difference.

All tests of significance were evaluated using an alpha or Type 1 error level of .05. If the probability of the statistic computed was less than .05, the null hypothesis was rejected and it was concluded that a significant difference existed. If the probability of the statistic was equal to or greater than .05, then the test failed to reject the null hypothesis and the researcher concluded that no significant difference could be proven to exist.

It should be noted that using the school mean instead of the individual student score reduced the total number of observations to less than thirty. This reduction in number of observations could cause a subsequent reduction in the sensitivity of some of the statistical procedures used in the study.
Chapter IV

PRESENTATION AND INTERPRETATION OF THE DATA

The intent of this research was to obtain and interpret data concerning the effectiveness and efficiency of an individualized instruction method (independent study) as compared to a group instruction method (lecture-discussion) in classes of basic vocational agriculture. A no instruction (control) group was also utilized to provide additional insight. Data were summarized and preliminary analyses were conducted to determine the most effective method for statistical analysis. Four major hypotheses were then tested.

With the exception of the calculation of pretest and posttest reliability coefficients, all data analyses were conducted using the school mean as the dependent variable. Tables showing the means for each variable and the number of students who took part in the study in each school are included as Appendix D of this report.

This chapter was concerned with the analysis, presentation, and interpretation of the data collected in this study. Major topics discussed herein include: (1) Description of the sample, (2) Preliminary analysis of the data, (3) Tests of Hypothesis 1, (4) Tests of Hypothesis 2, (5) Tests of Hypothesis 3, and (6) Tests of Hypothesis 4.

Description of the Sample

The sample used in this study consisted of one class of first year basic vocational agriculture students in each of twenty-three
Mississippi high schools. Nine schools were assigned to Group 1 of the study and administered the independent study treatment to their classes. Seven schools were assigned to the lecture-discussion treatment (Group 2) and seven schools were assigned to the control group (Group 3). There was a total of 455 students involved in this study with 175 receiving the independent study treatment, 157 receiving the lecture-discussion treatment, and 123 students serving in the control group.

The average size of the classes in all three treatment groups was 19.8 students. Classes in Group 1 had an average size of 19.4 students. In Group 2 there was an average of 22.6 students per class and in Group 3 class size averaged 17.6. The smallest class in the study had 9 students, while the largest class contained 37. Both of these classes were in the lecture-discussion treatment (Group 2). Of the 455 students in this study, 13.4 percent were female and 86.6 percent were male.

Means for each treatment group and a grand mean for all treatments were calculated for each of the six antecedent and eight dependent variables and are presented in Table 3. Standard deviations for each group mean and the overall mean are also shown in this table.

As is shown in Table 3, the average age of the students in this study was 14.93 years. The oldest class of students in the study had a mean age of 15.56 years; the youngest, a mean of 14.31. Means of treatment Groups 1-3 were 14.81, 15.03, and 14.98 for each respective treatment. Examination of the individual student data showed that 41 percent of the participants in the study were 14 years old. Of the remainder, 32.4 percent were 15, 16.9 percent were 16, and 8.8 percent
### Table 3

Treatment Group Means, Grand Means and Standard Deviations
for Antecedent and Dependent Variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group 1*</th>
<th>Group 2**</th>
<th>Group 3***</th>
<th>All Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td><strong>Antecedent Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>14.81</td>
<td>.38</td>
<td>15.03</td>
<td>.54</td>
</tr>
<tr>
<td>Grade</td>
<td>9.34</td>
<td>.37</td>
<td>9.38</td>
<td>.41</td>
</tr>
<tr>
<td>Reading Test</td>
<td>35.30</td>
<td>5.20</td>
<td>36.05</td>
<td>5.10</td>
</tr>
<tr>
<td>Pretest 1</td>
<td>50.77</td>
<td>4.39</td>
<td>51.55</td>
<td>3.41</td>
</tr>
<tr>
<td>Pretest 2</td>
<td>48.86</td>
<td>2.29</td>
<td>46.92</td>
<td>3.49</td>
</tr>
<tr>
<td>Pretest 3</td>
<td>43.08</td>
<td>2.85</td>
<td>45.84</td>
<td>6.00</td>
</tr>
<tr>
<td><strong>Dependent Variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posttest 1</td>
<td>70.62</td>
<td>5.87</td>
<td>73.60</td>
<td>6.29</td>
</tr>
<tr>
<td>Time - Unit 1</td>
<td>2.96</td>
<td>.85</td>
<td>7.43</td>
<td>1.40</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>78.41</td>
<td>8.11</td>
<td>74.42</td>
<td>20.21</td>
</tr>
<tr>
<td>Posttest 2</td>
<td>66.50</td>
<td>11.20</td>
<td>69.85</td>
<td>6.96</td>
</tr>
<tr>
<td>Time - Unit 2</td>
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<td>1.45</td>
<td>8.43</td>
<td>1.90</td>
</tr>
<tr>
<td>Assignment 3</td>
<td>72.04</td>
<td>27.40</td>
<td>58.15</td>
<td>29.94</td>
</tr>
<tr>
<td>Posttest 3</td>
<td>66.54</td>
<td>9.39</td>
<td>71.46</td>
<td>5.90</td>
</tr>
<tr>
<td>Time - Unit 3</td>
<td>5.16</td>
<td>2.09</td>
<td>8.57</td>
<td>3.41</td>
</tr>
</tbody>
</table>

*Group 1 = Independent Study Treatment
**Group 2 = Lecture Discussion Treatment
***Group 3 = Control
were 17 years of age. Only .8 percent of the 455 students were 18 years or older.

The mean grade level of a class in the study was 9.41. The mean did not differ to any great extent among the three treatment groups. The mean grade level for Group 1 was 9.34, for Group 2 it was 9.38, and for Group 3, 9.54. For individual classes in the study the mean grade level ranged from a low of 9.00, indicating all students were freshmen, to a high of 10.25. Over all three groups, the composition of the total number of students by grade level was 70.2 percent freshmen, 20.7 percent sophomores, 5.6 percent juniors, and 3.5 percent seniors.

Examination of the raw data collected from the individual students revealed the scores on the standardized reading test ranged from 9 to 67 with a perfect score being 70. In terms of grade level equivalent this range was from a grade level of 2.3 to a level of over 12.9. The average individual score on the test was 36.90 with a standard deviation of 13.20. This individual mean represented a grade level equivalent of 8.3. When the cumulative frequencies of the individual scores were analyzed, it was found that: (1) the lower quartile of students was reading at a grade level of less than 6.3, (2) students in the second quartile were reading at a level of 6.3 to 8.0, (3) students in the third quartile were reading on a level of 8.1 to 10.0, and (4) the upper quartile of students was reading at a level of 10.1 to greater than 12.9.

Class means on the reading test ranged from 25.71 to 47.08 with a grand mean of all classes of 36.48. Means for the three treatment groups were Group 1 - 35.30, Group 2 - 36.05, and Group 3 - 38.42, with respective standard deviations of 5.2, 5.1, and 5.8.
As can be seen in Table 3, class means on the three unit pretests did not vary greatly among the three groups. The means indicated that each group tended to score highest on pretest 1 and then to score lower on each successive pretest. For pretest 1 the group means ranged from 50.77 to 51.55 over the three treatments with a grand mean of 51.13. In referring to the class means for each of the twenty-three schools in the study, it was found that the lowest mean for a class was 43.06 and the highest was 59.58. Both of these scores were in the control group.

For pretest 2 the grand mean of all classes was reported in Table 3 as being 48.73 with a standard deviation of 3.76. The three group means on pretest 2 were Group 1 - 48.86 with a standard deviation of 2.29, Group 2 - 46.92 with a standard deviation of 3.49 and Group 3 - 50.30 with a standard deviation of 5.10. Class means for pretest 2 ranged from 42.05 for a school in the lecture-discussion group to 56.67 for a school in the control group. The reader is again reminded that class means for each antecedent and dependent variable are found in Appendix D.

The grand mean for all classes on pretest 3 was 44.45 with a standard deviation of 4.31 points. Group 1 classes had a mean of 43.08 with a standard deviation of 2.85. Classes in the lecture-discussion treatment (Group 2) had a mean of 45.84 with a standard deviation of 4.01. The third group of classes (control) averaged 44.84 points with a standard deviation of 6.00. When the means of each school were reviewed, it was found that the lowest average for a class on pretest 3 was 37.79 and the highest was 52.50. These two extremes were found in Group 2 and Group 3 respectively.
Means and standard deviations of the groups and classes on the eight dependent variables are discussed as related to the appropriate hypothesis.

Information on the overall grade average of the students in all classes and the occupational objective of the students was obtained from the opinionnaire administered to students in the two treatment groups. It should be noted that responses to the opinionnaire were received from only eleven of the sixteen schools in these two groups with a total of 216 students responding. Of those students responding to the item concerning their occupational goal, 25.2 percent stated that they planned to attend college and major in a subject other than agriculture upon leaving high school. Fifty-six of the respondents (26.2 percent) reported that they were undecided about their future goal or occupational objective. Fourteen percent of the students aspired to work in a non-agricultural job upon completion of their high school career. Students who desired to enter the fields of farming and agricultural mechanics accounted for 11.7 and 6.1 percent, respectively. Eight and four-tenths percent of the respondents planned to enter the military upon leaving high school. The remaining 8.4 percent of the students listed occupational objectives related to forestry, horticulture, agribusiness, natural resources, and professional agricultural jobs.

Students responding to the opinionnaire were asked to indicate their overall grade average in all courses. Only 2.8 percent of these students indicated that their overall average was below 70. A grade average range of 70 to 79 was reported by 34.1 percent of the respondents and of 80 to 89 by 47 percent of the sample. Sixteen percent of the students indicated that their overall grade average was 90 or more.
Data on the number of years of teaching experience and type of teaching certificate held by the teachers involved in the study were gathered from State Department of Education records. The least experienced teacher in the study had three years of teaching experience, and the most experienced teacher had 34. The average amount of experience held by the teachers was 12.7 years. Of the twenty-three teachers who participated in this study, four held bachelor's level certificates (Class A), twelve held master's level certificates (Class AA), and seven held education specialist's (Class AAA).

**Preliminary Analysis of the Data**

Prior to the testing of the hypotheses of this study, several preliminary analyses of the data were conducted. The purpose of these analyses was to determine relationships between the antecedent and dependent variables in order to select the most effective statistical procedure for testing the hypotheses. Statistics used in these preliminary analyses included product moment correlation coefficients, analysis of variance, and test reliability coefficients.

The linear correlation (Pearson's product-moment coefficient) between each of the six antecedent and eight dependent variables was computed and tabularized in Table 4. As can be seen in this table correlations between antecedents and dependent variables were not significant at the probability level of .05 with the exception of the correlation of grade to student assignment 2 (r = .5057). The correlation of pretest to corresponding posttest was slight to none with coefficients ranging from .0314 (pretest 2 to posttest 2) to .2902 (pretest 1 to posttest 1). Reading test scores did not appear to
## Table 4

Correlation of Antecedent and Dependent Variables

<table>
<thead>
<tr>
<th>Antecedent Variables</th>
<th>Dependent Variables</th>
<th>Posttest 1</th>
<th>Time 1</th>
<th>SA 2</th>
<th>Posttest 2</th>
<th>Time 2</th>
<th>SA 3</th>
<th>Posttest 3</th>
<th>Time 3</th>
</tr>
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<tbody>
<tr>
<td>Reading Test</td>
<td></td>
<td>-.0944</td>
<td>.2276</td>
<td>.1209</td>
<td>.1909</td>
<td>.2156</td>
<td>.1452</td>
<td>-.1819</td>
<td>.2873</td>
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<tr>
<td>Grade</td>
<td></td>
<td>-.3778</td>
<td>.2477</td>
<td>.5057*</td>
<td>-.2541</td>
<td>.1396</td>
<td>.2952</td>
<td>-.0751</td>
<td>.1110</td>
</tr>
<tr>
<td>Age</td>
<td></td>
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<td>.0233</td>
<td>-.3044</td>
<td>.2658</td>
<td>-.2097</td>
<td>-.2386</td>
<td>-.0264</td>
</tr>
<tr>
<td>Pretest 1</td>
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<td>.0582</td>
<td>.2475</td>
<td>.3322</td>
<td>.1712</td>
<td>.2396</td>
<td>.1333</td>
<td>.2587</td>
</tr>
<tr>
<td>Pretest 2</td>
<td></td>
<td>-.2111</td>
<td>-.2451</td>
<td>.3872</td>
<td>.0314</td>
<td>-.3155</td>
<td>.3780</td>
<td>-.0985</td>
<td>-.2238</td>
</tr>
<tr>
<td>Pretest 3</td>
<td></td>
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<td>.2165</td>
<td>.3377</td>
<td>.0875</td>
<td>.1519</td>
<td>.4763</td>
<td>.0613</td>
<td>.2561</td>
</tr>
</tbody>
</table>

*P - .05
correlate to posttest scores or student assignment scores following any discernable pattern. They did appear to be a slight relationship between reading scores and time spent value on each of the three units \((r = .2156 \text{ to } .2873)\). There also appeared to be a marked relationship between the scores on pretests 2 and 3 and the two student assignments with coefficients ranging from \( .3377 \) to \( .4763 \).

The analysis of variance technique was applied to each of the antecedent variables in order to determine if any significant differences existed in the three groups prior to the administration of the treatments. Results of this analysis were summarized in Table 5. The resulting F values of the six tests ranged from \( .064 \) with a probability of \( .9379 \) for the test for differences in pretest 1 means to \( 1.492 \) (probability = \( .2490 \)) for the test for differences in pretest 2 means among treatment groups. Since all significance values for the calculated F's were above \( .05 \), it was concluded that no significant differences among the three groups could be proven to exist, as measured by the antecedent variables.

As a final preliminary analysis, a reliability coefficient was calculated for each pretest and posttest. The Kuder-Richardson Formula 21 as reported by Van Dalen (22, 141) was chosen. The reliability coefficient obtained under this formula was calculated using the mean score of all students and the variance of this mean. In order to utilize \( \text{KR}_{21} \), it was necessary to convert the means and variances of each test from a 100 point scale to a 20 point scale, allowing 1 point for each correct answer. Converted means, variances, and reliability coefficients were summarized in Table 6.
Table 5
Analysis of Variance of Antecedent Variables Means

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group 1 Mean</th>
<th>Group 2 Mean</th>
<th>Group 3 Mean</th>
<th>F</th>
<th>Significance</th>
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<td>Age</td>
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<td>15.03</td>
<td>14.98</td>
<td>.554</td>
<td>.5834</td>
</tr>
<tr>
<td>Grade</td>
<td>9.34</td>
<td>9.38</td>
<td>9.54</td>
<td>.578</td>
<td>.5699</td>
</tr>
<tr>
<td>Reading Test</td>
<td>32.30</td>
<td>36.05</td>
<td>38.42</td>
<td>.702</td>
<td>.5074</td>
</tr>
<tr>
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<td>51.17</td>
<td>.064</td>
<td>.9379</td>
</tr>
<tr>
<td>Pretest 2</td>
<td>48.86</td>
<td>46.92</td>
<td>50.30</td>
<td>1.492</td>
<td>.2490</td>
</tr>
<tr>
<td>Pretest 3</td>
<td>43.07</td>
<td>45.84</td>
<td>44.84</td>
<td>.835</td>
<td>.4484</td>
</tr>
</tbody>
</table>

Group 1 = Independent Study Group; Group 2 = Lecture Discussion Group; Group 3 = Control Group
As can be seen in Table 6, reliability coefficients for the three pretests were low, ranging from .1420 to .2475. Reliability coefficients for the posttests were moderate (.6101 to .7407). Since each pretest-posttest pair consisted of twenty items testing the same concepts, the difference in measured reliability was difficult to explain. Mehrens and Lehman (14, 117) stated that tests with little variability among the scores gave lower reliability estimates than tests in which the score variability was larger. Also the effect of guessing answers could have lowered the pretest reliability measure.

Table 6
Means, Variances, and Reliability Coefficients for Pretests and Posttests

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean</th>
<th>Variance</th>
<th>Reliability Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest 1</td>
<td>10.22</td>
<td>6.53</td>
<td>.2475</td>
</tr>
<tr>
<td>Pretest 2</td>
<td>9.71</td>
<td>5.91</td>
<td>.1634</td>
</tr>
<tr>
<td>Pretest 3</td>
<td>8.94</td>
<td>5.71</td>
<td>.1420</td>
</tr>
<tr>
<td>Posttest 1</td>
<td>13.84</td>
<td>10.14</td>
<td>.6101</td>
</tr>
<tr>
<td>Posttest 2</td>
<td>12.97</td>
<td>11.50</td>
<td>.6352</td>
</tr>
<tr>
<td>Posttest 3</td>
<td>12.78</td>
<td>15.56</td>
<td>.7407</td>
</tr>
</tbody>
</table>

Based upon the preliminary analysis of the data, a decision was made concerning statistical techniques for testing Hypotheses 1-3 of the study. It was originally proposed to utilize the analysis of covariance procedure in testing these hypotheses, using pretest and reading test scores as covariates. Dunn and Clark (7, 330) reported
two reasons for using analysis of covariance in the place of analysis of variance. These reasons were (1) to reduce the variance of the sample means, and (2) to remove the effect of unwanted variables. They provided a rough rule of thumb stating that if the covariate-dependent variable correlation coefficient was less than .3, then it was more sensible to perform the analysis of variance. Kerlinger (13, 276) supported this rule by stating, "The higher the correlation, the larger the systematic variance that can be extracted from the total variance."

In relation to Hypothesis 1, therefore, the decision was made to use analysis of variance in the place of the covariance method because: (1) correlations between the two covariates and the dependent variables were generally less than .3, (2) no significant differences existed among the three treatment groups as measured by the covariates, and (3) reliability coefficients of the pretests were unacceptably low.

The Student's t distribution was chosen in place of the analysis of covariance as the appropriate test of Hypotheses 2 and 3. The rationale for this choice was based upon the reasons listed above.

**Test of Hypothesis 1**

Hypothesis 1 of this study stated that: "There is no significant difference in student achievement as measured by the unit posttests among the independent study, lecture discussion, and control (no treatment) groups." In order to test this hypothesis, a univariate analysis of variance was performed on the group means on each of the three unit posttests. A mean for all three posttests was then computed and subjected to this same analysis. Since the results of these statistical procedures showed that a significant difference did exist
among the three treatments, a post hoc test (Scheffe's S method) of all pairwise comparisons was applied to determine where this difference existed.

Table 7 revealed the results of the analysis of posttest means for unit 1. Means for individual schools on posttest 1 ranged from a low of 47.14 in the control group to a high of 80.00 for two schools in the lecture-discussion group. Treatment group means for the independent study, lecture-discussion, and control groups were 70.62, 73.60, and 61.59, respectively. Corresponding standard deviations were 5.87, 6.29, and 8.81. The calculated F ratio of the test was 5.669 with a probability of .0112. Since this probability was less than .05, the researcher concluded that at least one of the three means was significantly different from the others and the Scheffe's S procedure was applied to determine which pairs of groups were different.

As can be seen in Table 7, the differences between the means of Groups 1 and 2, and Groups 1 and 3 were less than the computed S. The researcher concluded that the difference in the means of the independent study and lecture-discussion groups, and the independent study and control groups was not significant. The reader should note that the difference in the means of Groups 1 and 3 was almost equal to the calculated S, indicating that only "slight" significant differences existed. Since the difference in the means of Groups 2 and 3 was larger than the computed S with a probability level of .05, the researcher concluded that the classes in the lecture-discussion group did significantly better than those in the control group.

A similar analysis of variance was conducted on the means of posttest 2 and was tabularized in Table 8. When the means for
Table 7
Analysis of Variance of Posttest 1 Means by Treatment Group

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Independent Study</td>
<td>70.62</td>
<td>5.87</td>
<td>9</td>
</tr>
<tr>
<td>2. Lecture Discussion</td>
<td>73.60</td>
<td>6.29</td>
<td>7</td>
</tr>
<tr>
<td>3. Control</td>
<td>61.59</td>
<td>8.81</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>68.78</td>
<td>8.35</td>
<td>23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>F Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>554.92</td>
<td>277.46</td>
<td>5.669</td>
<td>.0112</td>
</tr>
<tr>
<td>Within Groups</td>
<td>20</td>
<td>978.83</td>
<td>48.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>1533.76</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scheffes S Test for Multiple Comparisons

| Comparison       | | |
|------------------|----------------|
|                  | x_j - x_i     | S (a=.05) |
| Group 1 to Group 2 | 2.98           | .932      |
| Group 1 to Group 3 | 9.03           | .932      |
| Group 2 to Group 3*| 12.01          | .988      |

*Denotes pairs of groups significantly different at the .05 level.
Table 8

Analysis of Variance of Posttest 2 Means by Treatment Group

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Independent Study</td>
<td>66.50</td>
<td>11.20</td>
<td>9</td>
</tr>
<tr>
<td>2. Lecture Discussion</td>
<td>69.85</td>
<td>6.96</td>
<td>7</td>
</tr>
<tr>
<td>3. Control</td>
<td>54.31</td>
<td>4.82</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>63.81</td>
<td>10.41</td>
<td>23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>F Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>952.34</td>
<td>476.17</td>
<td>6.646</td>
<td>.0061</td>
</tr>
<tr>
<td>Within Groups</td>
<td>20</td>
<td>1433.00</td>
<td>71.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>2385.34</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scheffes S Test for Multiple Comparisons

| Comparison               | $|\bar{x}_i - \bar{x}_j|$ | S (a=.05) |
|--------------------------|--------------------------|-----------|
| Group 1 to Group 2       | 3.35                     | 11.28     |
| Group 1 to Group 3*      | 12.19                    | 11.28     |
| Group 2 to Group 3*      | 15.54                    | 11.96     |

*Denotes pairs of groups significantly different at the .05 level.
individual schools on posttest 2 were consulted, it was found that a range from 49.29 to 93.08 existed. Means for each treatment group and corresponding standard deviations were: (1) independent study - mean 66.60, standard deviation 11.20; (2) lecture-discussion - mean 69.85, standard deviation 6.96; and (3) control - mean 54.31, standard deviation 4.81. The analysis of variance of these means resulted in an F ratio of 6.646. Since the computed probability of this ratio (.0061) was less than .05, the researcher concluded that at least one of the three treatment means was significantly different from the other two and the Scheffe's S test was applied to all possible pairwise comparisons.

Results of the Scheffe's S test were shown in the lower section of Table 8. The difference in the means of Groups 1 and 2 was less than the computed value of S with a probability of .05. The researcher concluded that this difference was not significant. The difference in the means between Groups 1 and 3, and Groups 2 and 3, however, was greater than the computed S. The researcher concluded that these two pairs of means were significantly different when judged with an alpha level of .05. Both the independent study and lecture-discussion groups were shown to be significantly superior to the no treatment method.

Table 9 was developed to display the results of the analysis of variance and post hoc comparisons of treatment group means on posttest 3. In examining the individual school means now tabularized in Appendix D of this report, the range of these means was found to be from 41.94 for a school in the control group to 78.86 for a school in the lecture-discussion group. As can be seen in Table 9, group means were 66.54 for Group 1, 71.46 for Group 2, and 49.99 for Group 3.
Table 9

Analysis of Variance of Posttest 3 Means
By Treatment Group

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Independent Study</td>
<td>66.54</td>
<td>9.39</td>
<td>9</td>
</tr>
<tr>
<td>2. Lecture Discussion</td>
<td>71.46</td>
<td>5.90</td>
<td>7</td>
</tr>
<tr>
<td>3. Control</td>
<td>49.99</td>
<td>6.20</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>63.00</td>
<td>11.56</td>
<td>23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>F Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>1798.09</td>
<td>899.04</td>
<td>15.72</td>
<td>.0001</td>
</tr>
<tr>
<td>Within Groups</td>
<td>20</td>
<td>1143.83</td>
<td>57.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>2941.91</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scheffes S Test for Multiple Comparisons

| Comparison | \(|x_{j} - x_{i}| | S (a=.05) |
|------------|-----------------|----------|
| Group 1 to Group 2 | 4.92         | 10.08    |
| Group 1 to Group 3 * | 16.55        | 10.08    |
| Group 2 to Group 3 * | 21.47        | 10.69    |

*Denotes pairs of groups significantly different at the .05 level.
Corresponding standard deviations were 9.39, 5.90, and 6.20. The grand mean of all three groups was 63.00 with a standard deviation of 11.56. When the F ratio for the analysis of variance was calculated, it was found to be 15.72 with a probability of .0001. The researcher then concluded that at least one of the treatment means differed from the others, and applied the Scheffe procedure for multiple comparisons.

Results of the post hoc comparisons of the difference in treatment group means were tabularized in the lower portion of Table 9. The difference between the means of Group 1, independent study, and Group 2, lecture-discussion, was less than the calculated S with a probability of .05. When the difference between means of Groups 1 and 3, and 2 and 3 was determined, these were found to exceed the calculated value of S. The researcher concluded that the means of the independent study and lecture-discussion groups were significantly higher than the mean of the control group.

As a final test of Hypothesis 1, a mean of all posttests was derived for each school and subjected to analysis of variance. The results of this analysis were tabularized in Table 10. The overall mean of the three posttests was found to be 67.89 with a standard deviation of 6.93 units for the nine schools in Group 1. The schools in Group 2 had an overall posttest mean of 71.64 with a standard deviation of 4.30. Mean and standard deviation for the seven schools in the control group was 55.29 with a standard deviation of 8.97. The grand mean and standard deviation for all schools was 65.20 and 8.97, respectively. The analysis of variance of the three treatment means yield an F ratio of 14.28. The probability of this ratio was calculated to be .0001. Since this calculated probability was less than .05, the
Table 10
Analysis of Variance of the Overall Posttests Means
By Treatment Group

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Independent Study</td>
<td>67.89</td>
<td>6.93</td>
<td>9</td>
</tr>
<tr>
<td>2. Lecture Discussion</td>
<td>71.64</td>
<td>4.30</td>
<td>7</td>
</tr>
<tr>
<td>3. Control</td>
<td>55.29</td>
<td>6.24</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>65.20</td>
<td>8.97</td>
<td>23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>F Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>1041.40</td>
<td>520.70</td>
<td>14.28</td>
<td>.0001</td>
</tr>
<tr>
<td>Within Groups</td>
<td>20</td>
<td>729.18</td>
<td>36.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>1770.58</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scheffes S Test for Multiple Comparisons

| Comparison       | $|\bar{x}_1 - \bar{x}_2|$ | S (a=.05) |
|------------------|-------------------------|----------|
| Group 1 to Group 2 | 3.75                    | 8.05     |
| Group 1 to Group 3* | 12.60                  | 8.05     |
| Group 2 to Group 3* | 16.35                  | 8.54     |

*Denotes pairs of groups significantly different at the .05 level.
researcher again concluded that a significant difference existed among the three means and applied the post hoc test to discover such difference(s).

Results of the Scheffe's S procedure yielded the same conclusions as were found concerning treatment means for posttests 2 and 3. The difference in the means of Groups 1 and 2 was judged to be nonsignificant. Differences in Groups 1 and 3, and 2 and 3 were shown to be significant at the .05 alpha level, since the value of S was less than the computed differences. The researcher again concluded that no significant differences existed between the independent study and lecture-discussion treatment group overall posttest means. Significant differences were detected between the lecture-discussion and control groups and between the independent study and control groups.

Briefly summarizing the results of the tests of Hypothesis 1, a significant difference was found to exist at the alpha level of .05 among the three treatment groups on each of the three unit posttests and the overall mean of these posttests. For posttest 1, this difference was determined to be between the lecture-discussion group and the control group. For posttests 2 and 3, and the overall mean of all posttests, significant differences were found between the independent study and control groups, and between the lecture-discussion and control groups.

Tests of Hypothesis 2

Hypothesis 2 of this study stated that: "There is no significant difference in student achievement as measured by student assignments administered to the independent study and lecture-discussion treatment
groups." The statistical procedure used to test this hypothesis was Student's t-test. Results of the tests were summarized in Table 11.

Group means for student assignment 2 were reported as 78.41 for the independent study treatment and 74.41 for the lecture-discussion treatment. Individual school means as can be seen in Appendix D varied considerably. For Group 1, the independent study treatment, school means ranged from 66.84 to 92.19. For Group 2, the means ranged from 43.11 to a perfect mean of 100. The variance for each group reflected this spread in scores, being 65.84 (standard deviation = 8.11) for Group 1 and 408.40 (standard deviation = 20.21) for Group 2. A preliminary F test yielded a ratio of 6.20 with a probability of .022. The researcher concluded that a true t-score could not be calculated. Instead an approximation of t was calculated using the separate variance estimate. The value of this approximation of t was .49 with 7.51 degrees of freedom. Since the probability level for this value (.595) was greater than .05, the test of means for student assignment 2 failed to reject the null hypothesis. It was concluded that the two groups did not differ significantly on the means of student assignment 2.

The second test of Hypothesis 2 was conducted on the means for student assignment 3. As can be seen in Table 11, the mean for Group 1 was 72.04 and for Group 2, 58.15. Variances for the two groups showed that considerable variation existed within each group with the variance of Group 1 being 751.03 (standard deviation = 27.40) and of Group 2 being 896.64 (standard deviation = 29.94). The means of individual schools in Group 1 on student assignment 3 ranged from 12.09 to a perfect score of 100. For Group 2 the corresponding range was 16.67 to 100.
Table 11

T-Test for Differences in Student Assignment Means
by Treatment Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>Mean</th>
<th>Variance</th>
<th>T-Value</th>
<th>DF</th>
<th>Prob. T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 2</td>
<td>Independent Study</td>
<td>78.41</td>
<td>65.84</td>
<td>.49*</td>
<td>7.51*</td>
<td>.595</td>
</tr>
<tr>
<td></td>
<td>Lecture-Discussion</td>
<td>74.42</td>
<td>408.40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assignment 3</td>
<td>Independent Study</td>
<td>72.04</td>
<td>751.03</td>
<td>.97</td>
<td>14</td>
<td>.350</td>
</tr>
<tr>
<td></td>
<td>Lecture-Discussion</td>
<td>58.15</td>
<td>896.64</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Because the variances of the two groups were unequal, a true T-score could not be calculated. The values shown in these two columns approximate the t distribution with the calculated degrees of freedom.
A preliminary F ratio of the two variances of scores on student assignment 3 yield an F value of 1.19 whose probability (.794) was judged to be nonsignificant at an alpha level of .05. The variances of the two groups were then pooled and a t-score calculated. The value of t was determined to be .97 with 14 degrees of freedom. The probability of such a value happening by chance was .359. Since this probability exceeded the .05 level, the researcher concluded that the difference between the means of Groups 1 and 2 was not significant.

Summarizing the results of the tests of Hypothesis 2, no significant differences were determined to exist between the means of the independent study and lecture-discussion treatment groups on either student assignment 2 or student assignment 3.

**Tests of Hypothesis 3**

The third hypothesis of this study stated: "There is no significant difference in the amount of time required to complete the independent study and lecture-discussion instructional units." The Student's t procedure was again chosen as the statistic for testing the difference in the two means. Results of the Student's t-test were summarized in Table 12.

For instructional unit 1 in this study, the group mean for the independent study group was 2.96 hours and for the lecture-discussion group it was 7.43 hours. Individual school means for Group 1 ranged from 1.66 to 4.16 hours. For Group 2, the means were from 6 to 10 hours. The variances for time spent in completing unit 1 were .73 (standard deviation = .85) for the independent study group and 1.96 (standard deviation = 1.4) for the lecture-discussion group.
Table 12

T-Test for Differences in Amount of Time Necessary to Complete Each Unit by Treatment Group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>Mean</th>
<th>Variance</th>
<th>T-Value</th>
<th>DF</th>
<th>Prob. T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1 Time</td>
<td>Independent Study</td>
<td>2.96</td>
<td>.73</td>
<td>-7.93</td>
<td>14</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Lecture-Discussion</td>
<td>7.43</td>
<td>1.96</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 2 Time</td>
<td>Independent Study</td>
<td>4.52</td>
<td>2.11</td>
<td>-4.67</td>
<td>14</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>Lecture-Discussion</td>
<td>8.43</td>
<td>3.62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 3 Time</td>
<td>Independent Study</td>
<td>5.16</td>
<td>4.37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lecture-Discussion</td>
<td>8.57</td>
<td>11.62</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
When the two variances were compared in the preliminary F test, the calculated value of F was found to be 2.70 with a probability of .195. Using a significance level of .05, the researcher concluded that the variances were equal and then computed a t-score using the pooled variance estimate. The value of t was determined to be -7.93 with 14 degrees of freedom and a probability of .000. Based upon this low probability, the researcher concluded that a significant difference existed between the two means and that for unit 1, the independent study group took less time to complete the unit than the lecture-discussion group took.

As can be seen in Table 12, the mean amount of time spent in completing instructional unit 2 was 4.52 hours for Group 1 and 8.43 hours for Group 2. Within the independent study group (Group 1), means for the individual schools ranged from 2.45 hours to 7.50 hours. Individual school means for the lecture-discussion group classes (Group 2) were from 7 hours to 10 hours. The variance for Group 1 was found to be 2.11 (standard deviation = 1.45). Group 2 had a variance of 3.62 or a standard deviation of 1.90.

When the two variances were compared in a preliminary F test, an F value of 1.70 was obtained. Since the computed probability of this F (.470) was greater than the .05, the researcher concluded that the variances were not significantly different. A true t-score was then calculated and determined to be -4.67 with 14 degrees of freedom. The probability of this t occurring by chance was determined to be .000. The researcher, therefore, concluded that a significant difference did exist between the two groups and that the classes who studied unit 2 using the independent study method took significantly less time to do so.

than the classes who studied the unit through lecture-discussion took.

Results of the t-test for differences in the amount of time taken by the two groups in studying instructional unit 3 were also tabularized in Table 12. On this unit, the independent study group required an average of 5.16 hours to complete all activities related to the unit. Individual school means ranged from 2.48 to 9.68. The variance of the mean times for Group 1 was 4.37 which is equivalent to a standard deviation of 2.09. The lecture-discussion classes took an average of 11.62 hours to complete unit 3. Individual class times ranged from 6 hours to 15 hours with a variance of 11.62. Standard deviation for classes in this group was 3.41.

When the two variances of the mean time spent completing unit 3 were compared in a preliminary F test, the probability of the F value obtained (2.66) was found to be .202. Since this probability was greater than .05, it was concluded that the two variances did not differ significantly. A t-test to determine significance of the difference in the two means was then computed using the pooled variance estimate. The value of the t-score obtained from this procedure was found to be -2.48 with 14 degrees of freedom and a probability of .027. Based upon the fact that this probability was less than .05, the researcher concluded that the difference between the average amount of time spent by the two groups was significantly different. Also, it was concluded that the classes in Group 1, the independent study treatment, took less time to complete unit 3 than the classes in Group 2 took.

To summarize the findings concerning Hypothesis 3, for each of the three instructional units, the independent study group took significantly less time to complete each unit than the other group.
Tests of Hypothesis 4

The fourth and final hypothesis of this study was that: "There is no significant difference of opinions among the following four groups concerning the content and methodology of instructional units and treatments: (a) teachers in the independent study group, (b) students in the independent study group, (c) teachers in the lecture-discussion group, and (d) students in the lecture-discussion group. Two semantic differential instruments consisting of nine pairs of bipolar adjectives were administered. Individual responses to each pair of adjectives were summed to produce an individual score. Individual scores were averaged together to produce school means for students and teachers. The univariate analysis of variance technique was used to test for a difference in school means.

The results of the analysis of variance of responses to the semantic differential addressed toward the concept of instructional method were summarized in Table 13. Teachers who administered the independent study treatment had a group mean of 45.14 with a standard deviation of 11.16. Individual teacher scores for this group ranged from 33 to 61. A perfect score on the instrument was 63.00. Students who received the independent study treatment had a mean score of 41.43 with a standard deviation of 3.32. The means of the classes receiving this treatment were from 36.56 to 46.52. Teachers who taught the units using the lecture-discussion approach had a mean and standard deviation of 49.50 and 4.44 respectively. Their individual scores ranged from 44 to 54. Students who were taught by the lecture-discussion method had an average class score of 46.21 and a standard deviation of 5.53. Individual class means were from 43.19 to 54.50.
## Table 13

Analysis of Variance of the Mean Scores of Opinions Concerning Instructional Method by Treatment Group

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indep. Study Teachers</td>
<td>45.14</td>
<td>11.16</td>
<td>7</td>
</tr>
<tr>
<td>Indep. Study Students</td>
<td>41.43</td>
<td>3.32</td>
<td>7</td>
</tr>
<tr>
<td>Lecture-Disc. Teachers</td>
<td>49.50</td>
<td>5.53</td>
<td>4</td>
</tr>
<tr>
<td>Lecture-Disc. Students</td>
<td>46.21</td>
<td>5.53</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>44.95</td>
<td>7.37</td>
<td>22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>F Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3</td>
<td>176.34</td>
<td>58.78</td>
<td>1.098</td>
<td>.3758</td>
</tr>
<tr>
<td>Within Groups</td>
<td>18</td>
<td>963.58</td>
<td>53.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>21</td>
<td>1139.92</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
When all group means were compared to the perfect score of 63.00 points, it was observed that scores tended to lie well above the neutral point of 31.5. It was concluded that teacher and student opinion toward both methods of instruction was favorable.

In order to determine if differences existed among the four groups of respondents, an analysis of variance was conducted upon the group means. The results of this analysis were incorporated into Table 13. As can be seen in this table, the resulting F ratio was 1.098 with a probability of .3758. Since this probability was greater than .05, the test failed to reject the null hypothesis and the researcher concluded that no significant difference could be proven to exist between the four groups of respondents.

A second analysis of variance was calculated to determine if students and teachers in the two treatment groups held significantly different opinions toward the concept of instructional content. This concept was measured using a second semantic differential instrument identical to the first. Results of the analysis are summarized in Table 14. Teachers in the independent study group had a mean score of 53.29 with a standard deviation of 6.70 points. Individual teachers scores ranged from 44 to 62. Students who completed the three units independently had a mean score of 42.67 on this instrument with a standard deviation of 4.31. Their individual class means ranged from 33.69 to 46. For teachers who taught the units by lecture-discussion methods, the mean score and its standard deviation were 52.50 and 5.80, respectively. The lowest score of an individual teacher was 47; the highest was 58. The classes receiving the lecture-discussion treatment had a computed mean of 46.89 and a standard deviation of 5.43 points.
Table 14
Analysis of Variance of the Mean Scores of Opinions Concerning Instructional Content by Treatment Group

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Independent Study Teachers</td>
<td>53.29</td>
<td>6.70</td>
<td>7</td>
</tr>
<tr>
<td>2. Independent Study Students</td>
<td>42.67</td>
<td>4.31</td>
<td>7</td>
</tr>
<tr>
<td>3. Lecture-discussion Teachers</td>
<td>52.50</td>
<td>5.80</td>
<td>4</td>
</tr>
<tr>
<td>4. Lecture-discussion Students</td>
<td>46.89</td>
<td>5.43</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>48.60</td>
<td>7.05</td>
<td>22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Ratio</th>
<th>F Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>3</td>
<td>472.47</td>
<td>157.49</td>
<td>4.92</td>
<td>.0110</td>
</tr>
<tr>
<td>Within Groups</td>
<td>18</td>
<td>570.18</td>
<td>31.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>1042.65</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 14 (Continued)

Scheffe's S Test for Multiple Comparisons

<table>
<thead>
<tr>
<th>Comparison</th>
<th>$\bar{x}_j - \bar{x}_i$</th>
<th>S (a=.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 to Group 2*</td>
<td>10.62</td>
<td>9.25</td>
</tr>
<tr>
<td>Group 1 to Group 3</td>
<td>.79</td>
<td>10.85</td>
</tr>
<tr>
<td>Group 1 to Group 4</td>
<td>6.40</td>
<td>10.85</td>
</tr>
<tr>
<td>Group 2 to Group 3</td>
<td>9.83</td>
<td>10.85</td>
</tr>
<tr>
<td>Group 2 to Group 4</td>
<td>4.22</td>
<td>10.85</td>
</tr>
<tr>
<td>Group 3 to Group 4</td>
<td>5.61</td>
<td>12.24</td>
</tr>
</tbody>
</table>

*Denotes pairs of groups significantly different at the .05 level.
Individual class means ranged from 43.52 to 55.00.

Using the benchmark for neutral scores as being 31.5, all mean responses toward the concept instructional content were judged to be favorable. A perfect score on the instrument was 63.00.

To determine if any group was significantly different from any other group, an analysis of variance was performed and the results summarized in Table 14. As can be seen in this table, the F ratio produced by this procedure was 4.92. Since its probability (.0110) was less than .05, the researcher concluded that at least one of the group means was different from the others and the post hoc Scheffe's S method was used to determine which means were different.

Results of the Scheffe's test are also included in Table 14. All values of S were computed using a probability level of .05 as the critical point. Of the six comparisons made in Table 14; only one, the comparison of teachers and students in the independent study group, had a difference in the two means which exceeded the value of S. The researcher then concluded that a significant difference did exist between these two groups. No significant differences in opinions toward the concept of instructional content were found between: (1) teachers in the independent study and lecture-discussion groups, (2) teachers in the independent study group and students in the lecture-discussion group, (3) teachers in the lecture-discussion group and students in that group, (4) students in the independent study and lecture-discussion groups, and (5) teachers in the lecture-discussion group and students in the independent study group.

To summarize the findings concerning Hypothesis 4:

1. Both student and teacher opinions toward the concepts of
instructional method and instructional content were judged to be favorable in both treatment groups.

2. No significant differences were evident among the four groups of respondents concerning their opinions toward the concepts of instructional method.

3. When mean scores on the semantic differential addressed to the concept, instructional content, were analyzed, a significant difference was indicated by the analysis of variance. The post hoc test showed that a significant difference did exist between the opinions of students and teachers in the independent study group. This difference implied that the teachers held a more favorable opinion toward the concept than the students did. No significant differences were found between the following groups: (a) teachers in the independent study and lecture-discussion groups, (b) independent study teachers and lecture-discussion students, (c) teachers and students in the lecture-discussion group, (d) students in the two treatment groups, and (e) lecture-discussion teachers and independent study students.
Chapter V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study was addressed toward a comparison of an individualized instruction method (independent study) and a group instruction method (lecture-discussion). A control group (no instruction) was also utilized as a benchmark for comparing the two methods. Stated in question form the problem was, "Can independent study modules be utilized as effectively as the group instruction process in Mississippi basic vocational agriculture programs?"

Three specific objectives of the study were outlined as:

1. To develop three individualized instruction modules from existing group instruction units for basic vocational agriculture classes.

2. To compare the effectiveness and efficiency of these individualized modules to the group instruction units in terms of student achievement on the unit posttests and student assignments and in terms of time required to complete each unit.

3. To compare student and teacher opinion toward the content of the units and the two methods of instruction.

In relation to objectives 2 and 3, four hypotheses were formulated and subjected to statistical analyses. These were:

1. There would be no significant difference in student achievement as measured by the unit posttests among the independent study, lecture-discussion, and control (no treatment) groups.
2. There would be no significant difference in student achievement as measured by student assignments administered to the independent study and lecture-discussion treatment groups.

3. There would be no significant difference in the amount of time required to complete the independent study and lecture-discussion units.

4. There would be no significant difference of opinions of the following four groups concerning the content and methodology of the instructional units and treatments: (a) teachers in the independent study group, (b) students in the independent study group, (c) teachers in the lecture-discussion group, and (d) students in the lecture-discussion group.

Summary of the Procedures

This study utilized the pretest-posttest control group experimental design. A sample was selected and assigned to treatment at random from the population of Mississippi schools teaching basic vocational agriculture. Nine schools were assigned to the independent study treatment with seven schools being assigned to the lecture-discussion treatment and seven being assigned to the control group.

Three independent study units of instruction were developed by the author for use in this study from rough drafts of materials previously developed for group study. The units were reviewed for technical accuracy prior to preparation of the final copy. A unit pretest and posttest were developed to accompany each unit. Student assignments were also prepared for two of the units to serve as measures of student achievement. A student-teacher questionnaire was prepared
utilizing the semantic differential technique to measure opinion on the concepts instructional method and instructional content.

All treatments and instruments developed by the author were field-tested prior to preparation of the final copies. Final copies of the instructional units were bound and published as publications of the Research and Curriculum Unit, Mississippi State University.

Prior to the conduct of the study, teachers from the selected schools attended an inservice training program designed to acquaint them with the objectives and methodology of the study.

The California Achievement Test of Reading Ability, Level 18 was chosen as a possible covariate to be included in the study. Tests were administered at random to classes in the study during the data collection period.

Administration of the treatments began on or about October 20, 1980. Teachers in all three treatments groups were furnished detailed instructions on administration of the teaching method, pretests, student assignments, posttests, and the questionnaire. Copies of the answer keys to all pretests, assignments, and posttests were provided to each teacher. They were asked to grade each of these instruments following established procedures and to return these grades on a special grade reporting form. Answer sheets for the reading test and the questionnaire used in the study were scored by the researcher as they were returned.

As answer sheets, grade report forms and questionnaires were returned, the data were transferred to computer coding sheets and then to standard IBM-type computer cards. The computer facilities at Mississippi State University were used to analyze the data. All
analyses were accomplished by using the program SPSS, Statistical Package for the Social Sciences. A mean score on each variable was calculated for each school. This school mean served as the dependent variable for all further tests of hypotheses. There were six antecedent variables which were utilized in this study. These were age, grade level, reading test score, pretest 1 score, pretest 2 score, and pretest 3 score. Eight measures served as dependent variables including posttest 1 score, time to complete unit 1, student assignment 2 score, posttest 2 score, time to complete unit 2, student assignment 3 score, posttest 3 score, and time to complete unit 3 score.

Descriptive measures used to summarize the data in this study in addition to the school mean included the group mean, group standard deviation, group variance, and the grand mean for all groups. Inferential statistics and techniques used to analyze the data were Pearson's r, univariate analysis of variance, and Student's t. When the analysis of variance indicated that a difference in the group means did exist, Scheffe's S method for multiple comparisons was selected as the appropriate post hoc test. All tests of statistical significance were evaluated using an alpha level of .05.

Summary of the Data Analyses

In addition to providing descriptive information related to the sample, preliminary data analyses were utilized to aid in the selection of appropriate statistical techniques for testing major hypotheses. Originally it was proposed that the analysis of covariance be used to test Hypothesis 1-3 of the study. Since the correlation between the antecedent variables and dependent variables was only
slight and no apparent differences as measured by the antecedent variables existed between the treatment groups, it was decided to use the simpler analysis of variance procedure to test Hypothesis 1. Hypotheses 2 and 3 were tested using the Student's t distribution or its approximation. The analysis of variance was used again to test Hypothesis 4 concerning student-teacher opinions toward content and methodology of the materials used in the study. The reader is again reminded that the low number of observations used in this study could possible affect the statistical tests employed.

Summary of the Major Findings

Findings Related to Hypothesis 1

In relation to this hypothesis concerning the effectiveness of the two instructional methods as measured by school posttest means, four statistical tests were conducted. The first test sought differences in the group means for posttest 1. A difference among the means was indicated. The post hoc comparisons revealed that the lecture-discussion method was significantly better than the no treatment (control) method when tested at the .05 alpha level. No significant differences on posttest 1 were indicated between the independent study treatment and the lecture-discussion treatment or the no treatment procedure.

A similar test for differences in the group means on posttests for units 2 and 3 yielded different results. Again the null hypothesis of no difference was rejected, but this time significant differences were found between the independent study group and the control group and between the lecture-discussion group and the control group. No
significant difference was indicated by the Scheffe test between independent study and lecture-discussion treatments.

As a final test of Hypothesis 1, an overall posttest mean was calculated for each school. Analysis of the variance of these means yielded the same results as in the preceding paragraph. The null hypothesis was rejected and significant differences between the two treatment groups and the control group were discovered. No significant difference was revealed between the independent study and lecture-discussion treatments.

Findings Related to Hypothesis 2

Testing of this hypothesis was designed to determine if a difference existed in the school means on the two student assignments. The Student's $t$ distribution or its approximation was selected as the appropriate test statistic. Results of the test for equality of the means of the two groups on both assignment 2 and assignment 3 failed to show that a significant difference existed. The researcher concluded that the two groups were equal.

Findings Related to Hypothesis 3

Hypothesis 3 was designed to investigate the differences in the average amount of time required by the independent study and lecture-discussion groups to complete each of the three units of instruction. The Student's $t$ distribution was again chosen as the appropriate test statistic. $T$-scores were calculated on the difference of the two means for each of the units. The results of the tests indicated that the independent study group took a significantly shorter length of time to complete each unit than the lecture-discussion group.
Findings Related to Hypothesis 4

The fourth hypothesis of this study was addressed toward opinions of students and teachers in the two treatment groups concerning the concepts of instructional method and instructional content. The univariate analysis of variance procedure was chosen to test this hypothesis using student and teacher means computed from a semantic differential administered for each concept.

In relation to the respondent's conception of the instructional method of the materials, no significant differences were indicated by the statistical test in the opinions of the four groups of students and teachers. Their overall opinions of the independent study and lecture-discussion methods was judged to be equally favorable.

Responses concerning the concept of instructional content were also judged to be favorable. The analysis of variance conducted upon the mean response, however, indicated that at least one of the groups differed from the others. The Scheffe's S procedure revealed that this difference was between the students in the independent study group and the teachers in that group. The students were found to have a significantly lower opinion toward the content of the three units.

Conclusions

Based upon the interpretation of the data, the following conclusions were reported:

1. That the use of either the independent study method or the lecture-discussion method was superior to no instruction.

2. That the independent study method was as effective in teaching the content of the three instructional units as the traditional
lecture-discussion method.

3. That the independent study method was as effective as the lecture-discussion method in teaching problem-solving skills.

4. That the independent study method was more efficient in terms of time spent on completing a unit of instruction than the lecture-discussion method was.

5. That teacher and student opinions toward the concept of instructional method were generally favorable. It was also concluded that the teachers and students in both treatment groups did not differ significantly in their opinion toward independent study or group study.

6. That teacher and student opinions toward the concept of instructional content of the three units were also generally favorable. It was also concluded that students in the independent study treatment tended to have lower opinions toward the content of the units than their teachers held.

**Recommendations**

On the basis of the review of literature, the interpretation of the data and the researcher's own experiences in conducting this study and developing curriculum materials, the following recommendations were offered:

1. That a study be conducted using the randomized block procedure to see if differences existed between independent study and group study methods. Blocks for the design of this study would be determined by measurement of variables such as reading ability or overall academic performance.
2. That a study be conducted using a repeated measurements design to investigate the effects of repeated use of independent study materials over an extended period of time.

3. That a study be conducted to determine how affective characteristics of teachers and students affect the usability of independent study materials.

4. That a study be conducted to further evaluate the efficiency of independent study methods in terms of time, effort, and cost.
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APPENDIX A

Final Outline

Lesson Plans for Teaching Basic Vocational Agriculture
Final Outline

Lesson Plans for Teaching Basic Vocational Agriculture

Section I. Introduction to Basic Vocational Agriculture

Lesson 1. Orientation to Vocational Agricultural Education
Lesson 2. Careers in Agriculture, Agribusiness, and Natural Resources Occupations
Lesson 3. Selecting a Supervised Occupational Experience Program
Lesson 4. Planning a Supervised Occupational Experience Program
Lesson 5. Keeping Records of a Supervised Occupational Experience Program
Lesson 6. Orientation to the FFA
Lesson 7. Instructional Activities of the FFA

Section II. Introduction to Livestock Production

Lesson 8. Orientation to Livestock Production in Mississippi
Lesson 9. Breeds of Beef Cattle
Lesson 10. Breeds of Dairy Cattle
Lesson 11. Breeds of Hogs
Lesson 12. Breeds of Chickens
Lesson 13. Selecting Beef Cattle
Lesson 14. Selecting Dairy Cattle
Lesson 15. Selecting Hogs

Section III. Introduction to Soil Conservation and Management

Lesson 16. Measurement of Land Area
Lesson 17. Legal Description of Land
Lesson 18. Components of Soil
Lesson 19. Properties of Soil
Lesson 20. Classification of Soil

Section IV. Introduction to Crop Production
Lesson 21. Crop Production Enterprises in Mississippi
Lesson 22. Forage Production Enterprises in Mississippi
Lesson 23. Plant Selection
Lesson 24. Seedbed Preparation
Lesson 25. Plant Nutrients
Lesson 26. Determining Fertilizer Levels

Section V. Introduction to Agricultural Mechanics
Lesson 27. Using Agricultural Carpentry Tools
Lesson 28. Using Metal Working Tools
Lesson 29. Using Wrenches, Pliers, and Screwdrivers
Lesson 30. Using Fasteners
Lesson 31. Arc Welding Skills
Lesson 32. Oxyacetylene Cutting Skills
Lesson 33. Agricultural Carpentry Skills
Lesson 34. Agricultural Electrification Skills
Lesson 35. Agricultural Plumbing Skills
Lesson 36. Agricultural Concrete Skills
APPENDIX B

Performance Objectives for Selected Units
Performance Objectives  
Lesson 21  
Crop Production Enterprises in Mississippi

A. Terminal Objective. Upon completion of this lesson, the student will be able to describe the nature of major and minor crop enterprises in the state. In describing the nature of each enterprise, the student will discuss the scope and size of the enterprise, identify the products produced by the enterprise, and discuss practices of the production process.

B. Specific Objectives. Upon completion of this unit, the student will be able to:

1. Define new terms related to crop production.
2. Describe the nature of cotton production.
3. Describe the nature of soybean production.
4. Describe the nature of rice production.
5. Describe the nature of corn production.
6. Describe the nature of small grain production.
7. Describe the nature of truck crop production.
8. Describe the nature of other minor crop enterprises.
Performance Objectives
Lesson 23
Plant Selection

A. **Terminal Objective.** Upon completion of this unit, the student will be able to describe the factors to be considered in selecting a crop enterprise, to select a best suited variety of a plant, and to evaluate the quality of seed using seed certification labels.

B. **Specific Objectives.** Upon completion of this unit, the student will be able to:

1. Define new terms related to crop and plant selection.
2. Describe factors to be considered in selecting a crop enterprise.
3. Describe general factors to be considered in selecting a crop variety.
4. List sources of information related to crop variety selection.
5. Describe the factors to be considered in selecting seed of a given variety.
6. Select a variety of soybeans for planting given a set of farming conditions.
7. Select the most economical seed given the characteristics of two different seed batches.
Performance Objectives

Lesson 25

Plant Nutrients

A. **Terminal Objective.** Upon completion of this unit, the student will be able to discuss plant nutrients and their functions, the relationships of liming and pH, fertilizer analysis and the methods and timing of fertilizer application.

B. **Specific Objectives.** Upon completion of this unit the student will be able to:

1. Define new terms related to plant nutrients.
2. List the major and minor plant nutrients and their functions.
3. Describe the relationship of pH to soil fertility.
4. Describe the methods used to grade fertilizer.
5. Name sources of plant nutrients.
6. Describe the methods of fertilizer application.
7. Identify fertilizer and liming timing schedules.
8. Calculate the least expensive source of a fertilizer element.
APPENDIX C

Pretest - Unit 21

Unit 21

Posttest - Unit 21

Pretest - Unit 23

Unit 23

Assignment - Unit 23

Posttest - Unit 23

Pretest - Unit 25

Unit 25

Assignment - Unit 25

Posttest - Unit 25

Student Questionnaires
PRETEST
UNIT 21

This test is designed to see how much you already know about the topic of this unit. It will not count as a grade.

Multiple choice. Place a check by the best answer to each statement or question.

1. The most important rowcrops in Mississippi are:
   ___ a. Corn and cotton
   ___ b. Sunflowers and soybeans
   ___ c. Soybeans and corn
   ___ d. Soybeans and cotton

2. Chemicals which are used to control weeds are called:
   ___ a. Fungicides
   ___ b. Herbicides
   ___ c. Insecticides
   ___ d. Weedicides

3. Crops which can be planted by broadcasting include:
   ___ a. Corn and truck crops
   ___ b. Cotton and soybeans
   ___ c. Soybeans and sunflowers
   ___ d. Rice and small grains

4. Two crops which are mainly grown because they contain vegetable oils are:
   ___ a. Corn and wheat
   ___ b. Rice and small grains
   ___ c. Soybeans and sunflowers
   ___ d. Sorghum and corn

5. Which one of the following crops is usually not grown as a cash crop in Mississippi?
   ___ a. Cotton
   ___ b. Soybeans
   ___ c. Corn
   ___ d. Rice
6. One reason why some farmers have switched to soybeans in the place of cotton is that:
   ___ a. Production costs are lower
   ___ b. Soybeans can be planted easier
   ___ c. Cotton seed is hard to get
   ___ d. Demand for cotton has dropped

7. Level soils which are deep and well drained are suitable for any crop except:
   ___ a. Cotton
   ___ b. Rice
   ___ c. Soybeans
   ___ d. Corn

8. A combine cannot be used to harvest:
   ___ a. Cotton
   ___ b. Rice
   ___ c. Soybeans
   ___ d. Corn

9. Most crops are usually planted in the spring and harvested in the fall except:
   ___ a. Corn
   ___ b. Wheat
   ___ c. Rice
   ___ d. Sunflowers

10. The only rowcrop grown in noticeable amounts throughout the state is:
    ___ a. Corn
    ___ b. Cotton
    ___ c. Soybeans
    ___ d. Rice

True/False. Circle T if the statement is true and F if it is false.

T F 1. The Mississippi Delta is an important section of the state for production of cotton, rice, and soybeans.

T F 2. Cottonseed meal and soybean meal are used mainly for feeding livestock.

T F 3. Rice is grown in fields which are flooded with water to a depth of 12 to 18 inches.
T  F  4. Cotton and corn are planted in May and June.

T  F  5. The practices used to grow corn and sorghum are very similar.

T  F  6. A cotton gin is used to process cottonseed into oil and meal.

T  F  7. Soybeans and sunflowers can be grown in a double cropping system.

T  F  8. Soybeans are usually planted in March and April.

T  F  9. Most farmers use herbicides and cultivation to control weeds in soybeans, cotton, and corn.

T  F  10. Class I & II land is usually suitable for rice production.
INDEPENDENT STUDY UNITS
FOR
BASIC VOCATIONAL AGRICULTURE

Unit 21

Rowcrop Production in Mississippi

Student Name: ________________________
Class: _________________________________
School: _______________________________
INDEPENDENT STUDY UNITS FOR BASIC VOCATIONAL AGRICULTURE

UNIT 21

ROWCROP PRODUCTION IN MISSISSIPPI

COMPILED BY:
James S. McCully, Jr.
Research and Curriculum Specialist

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Jackson, Mississippi Mississippi State University
Mississippi State, Mississippi

October 1980
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Individualized Instruction Unit No. 21

ROW CROP PRODUCTION IN MISSISSIPPI

I. WHAT'S UP?

Rowcrop production in Mississippi is an important part of the agricultural economy of the state. In 1978 sales of rowcrop products earned almost 1.1 billion dollars for Mississippi farmers. This amount represents over one half of the cash income from the sales of all farm products. Rowcrops are grown in every section of the state. Much rowcrop production is found in the northwest and west central counties which are called the Mississippi Delta area.

For many years, all agricultural products in the state were ruled by "King Cotton". The price of cotton and the size of the crop affected not only farmers but also townspeople. When cotton yields and prices were up, everyone enjoyed good times. When they were down, however, everyone suffered. Today cotton is still an important cash crop, especially in the Mississippi Delta, but soybeans are equally important. Other rowcrops such as rice and sunflowers are helping to further balance the crop economy of the state.

This lesson is intended to develop your knowledge of the different rowcrops grown throughout Mississippi. Also you should learn about the different requirements and practices needed to profitably raise these crops.
II. YOUR OBJECTIVE:

When you finish this lesson you should be able to describe the nature of the major and minor rowcrop enterprises in the state. This means that you must be able to answer questions related to the scope and size of the rowcrop, the requirements and practices needed to grow the crop, and the end use of the crop when it is harvested. To successfully complete this lesson you must get at least 70 points from a total of 100 points on the lesson test.

III. MEETING YOUR OBJECTIVE:

In order to meet the objective above you should follow these steps:

A. Carefully read the material on the following pages labeled FYI (For Your Information). It contains all of the information you need to pass the test. Read it carefully and ask your teacher to explain any words or facts which you cannot understand.

B. After you have carefully read FYI, complete the "How Much Have You Learned?" section of the lesson. You will find a crossword puzzle, word completion games, and several questions which must be answered. Try to complete the learning activities without referring to FYI, but if you get stumped it's OK to turn back. When you think that all of your answers are right, have your teacher check them for you.

C. When you think that you are ready to take the lesson
test, ask your teacher. Remember that once you get the
test, you must complete it before the end of the class
period. You cannot work part of it today and then part
tomorrow. You cannot take the test home. Finally you
cannot use this lesson or any notes to help you.
IV. FYI (FOR YOUR INFORMATION):

A. New terms and definitions

1. Rowcrop - A crop which is usually planted in rows so that tractors can be used to cultivate and harvest it without bothering the plants of the crop.

2. Cash crop - Any crop which is grown for sale to someone off of the farm.

3. Broadcast crop - A crop which is usually planted by spreading the seed in an even pattern over the entire soil surface.

4. Double-cropping system - A method in which two crops are harvested from the same field during a one year period.

5. Herbicide - A chemical used to control unwanted plants. Herbicides are used to help control unwanted plants (weeds).

6. Insecticide - A chemical used to control insects.

7. Cultivation - A process which uses tools such as hoes and plows to remove weeds and stir the soil.

8. Class I land - Soils which are nearly level and have no problems that keep them from growing rowcrops. Very good land.

9. Class II land - Soils which have a gentle slope and require some special treatments to prevent erosion and to produce high yields. Good land.

10. Class III land - Soils which have a moderate slope
and need very special treatments to grow rowcrops and prevent erosion. Fair land.

11. Class IV land - For rice production purposes, soils which are nearly level and do not allow water to seep through easily.

12. Class V land - Soils which are nearly level and poorly drained.

B. What is the nature of cotton production in Mississippi?

Cotton is still a major cash crop in the state. In 1978 sales of cotton lint and seed amounted to almost forty percent of all crop sales. Almost 1.15 million acres of cotton were harvested that year and produced 1.38 million bales. Mississippi is the third largest cotton producing state in the U.S. Seventy percent of the cotton in the state is grown in the Delta area. Very little cotton is grown in the southern counties.

Cotton is best suited to Class I and Class II lands. The crop is usually planted in 36-to 40-inch rows. Most cotton is planted between April 10 and May 10. It requires rather high amounts of fertilizer and a soil which is low in acid content.

Cotton yields are easily reduced by a variety of damaging insects including the boll weevil and the boll worm. Most producers therefore depend upon regular
treatments of insecticides to protect their crop. They also use herbicides and cultivation to control weeds. Usually the cotton is ready for harvest by the middle of September. When the seed pods, or bolls as they are commonly called, have opened and the cotton fibers, or lint, are dry; mechanical cotton pickers remove the lint and seeds from the bolls. After picking, the lint and seeds are separated at a gin and the lint is pressed into 480 pound bales. These bales may then be sold or stored for later sale.

The price of cotton is based upon a number of factors including grade, season of the year, and supply. Cotton grades are determined by fiber color, fiber length, fiber strength, and trash content.

Cotton lint is used to produce a variety of cloth and paper products. Cotton seeds are processed to produce vegetable oil for cooking and cottonseed meal which is used to feed cattle and poultry.

C. What is the nature of soybean production in Mississippi?

In most areas of the state, the soybean has become the major cash crop. In 1978, there were 3.8 million acres of soybeans harvested and some 82 million bushels of the crop were sold. For every one acre of cotton that was harvested, three acres of beans were combined. Soybeans are the only rowcrop which is grown in
noticeable amounts in every county in the state. Almost one-half of the beans produced in Mississippi are grown in the Delta, however. In terms of income for the whole state, soybeans may produce more money than cotton one year and less money the next year.

Soybeans are suitable for planting on Class I, II, and III land. Since they are dependent upon a certain length of daylight for best growth, planting dates are different for different varieties and locations. In the northern two-thirds of the state, soybeans are usually planted from May 1 to June 20. Planting in the southernmost sections usually takes place from May 20 to June 25. Low to moderate amounts of fertilizer are required and the soil should be well limed for highest yields.

One reason why many farmers have switched to soybeans in place of cotton is the lower cost of production. Soybeans do not require as much fertilizer as cotton. They do not usually require as many insecticide sprayings as cotton does. Most farmers do use herbicides, as well as cultivation to help control weeds. Harvesting and processing costs for soybeans are lower than picking and ginning costs for cotton.

Soybeans are harvested by grain combines when the bean pods have dried. Some varieties are ready for combining by October 1 while others are not ready until
the latter part of that month. The seeds must have dried in the pods until their moisture content is down to 12 to 13 percent.

Once harvested, the soybeans can be sold immediately or stored in hopes of higher prices. They are processed at an oil mill and are used to make vegetable oil for cooking and soybean meal for feeding animals.

D. What is the nature of rice production in Mississippi?

Rice production in the state has tripled since 1973. In 1978, around 215,000 acres were harvested which produced over 9 million pounds of grain. Mississippi is the fifth largest rice producing state in the nation. All production of this crop is in the Delta section.

Rice is best suited to heavy clay soils which are nearly level and hold water well. Such soils are usually found on Class III, IV, or V land. The grain requires relatively low amounts of fertilizer. Depending upon the variety, planting dates range from April 15 to June 20.

The crop is planted using a grain drill in narrow rows or is broadcast from an airplane. After the seeds are in the ground, the field is flooded and then allowed to drain. When the seeds begin to come up, the fields are flooded with water again. As the plants begin to grow, the depth of the water is slowly increased until it is 3 or 4 inches deep. Special herbicides are used to control weeds. Small dams or levees are used to hold the
water in the fields throughout the growing season.

Rice is harvested with combines when the grains have dried to a moisture level of 17 to 23 percent. The field should be drained two to three weeks before harvest. Depending upon planting date and variety, harvesting may take place from late August to late October. After combining the grain is dried in bins and then stored or sold. Rice is processed and used as food for people.

E. What is the nature of corn production in Mississippi?

In comparison to other states, Mississippi does not produce much corn. In 1978, there were about 215,000 acres of corn planted. About two-thirds of these were harvested for grain and the rest was cut for silage or grazed. Over 7.5 million bushels of corn and 875,000 tons of silage were harvested. Corn is grown throughout the state except in the Delta area.

Corn is best suited to Class I and Class II soils which are well drained and have a sandy texture. Corn should be planted as soon as the danger of frost is over. In the southern half of the state, this time comes in early March. In the northern half, it is in late March or early April. Early plantings are needed for high yields.

Corn requires rather large amounts of fertilizer, especially nitrogen. Most farmers use herbicides and cultivation to control weeds. Usually the crop is
planted in 36- to 40-inch rows. Most producers plant at a rate to produce 12,000 to 15,000 plants per acre.

The ears of corn are harvested in the fall when the husks and grain have dried. A corn picker which snaps the ear from the stalk may be used. On some farms a grain combine is used which also shells the grains from the cobs. Moisture content should be 14 to 16 percent at the time of harvest. Most of the corn produced in Mississippi is used on the farm where it is grown and is not sold.

F. What is the nature of small grain production in Mississippi?

Mississippi is not a major small grain producing state. Acreage in small grains rises and falls from year to year. Much of the land planted to wheat and oats is used for winter grazing instead of grain production. In 1978, a little over 2 million bushels of wheat were harvested from 100,000 acres.

Wheat, oats, and other small grains are best suited to Class I land, although Class II and Class III land can be used. Small grains are usually planted in the fall. October 1-15 is a general planting time for north Mississippi and November 1-15 for south Mississippi. Seed are planted in narrow 7- to 10-inch rows or broadcast on a firm, well-prepared seedbed. Moderate amounts of fertilizer are required. Most farmers usually add extra
nitrogen fertilizers during the growing season.

Small grains are harvested in the late spring using combines. Most harvesting takes place from June 5 to June 15. Some farmers are trying to use a double cropping system. This involves raising a crop of wheat and a crop of soybeans on the same field during a one-year period. The soybeans are planted in June and harvested in October. Wheat is then planted and harvested in time to plant soybeans again. Almost all wheat is processed to make flour for bread, cakes, and other foods.

G. What is the nature of truck crop production in Mississippi?

Among the truck crops grown in Mississippi are peanuts, cucumbers, sweet potatoes, pimento peppers, watermelons, Southern peas, okra, and several other vegetables. In 1976, over 34,000 acres of these crops were harvested. Some of these crops, such as watermelons, peanuts, and sweet potatoes, are grown in large fields. The vegetable crops, though, are usually grown in small plots of 1 to 5 acres. These crops serve as sources of extra cash to many small farmers.

Watermelons are grown as a cash crop in the southern part of the state. They are planted from March 1 to March 15. Some growers plant earlier in a hotbed or
greenhouse and then move the young plants to the fields. Watermelons are best suited to sandy well-drained soils. They are planted in hills which are 8 to 10 feet apart. The melons are ready to be picked about 6 weeks after the blooms open. They are picked by hand and usually hauled to a central market for sale.

Cucumbers are grown as a cash crop by many small farmers. Usually only 1 to 5 acres of cucumbers are grown since they must be harvested frequently by hand. As soon as the danger of frost is over, the crop is planted on a well prepared seedbed. Harvesting begins when the cucumbers are 1 to 1 1/2 inches long. Usually the vines are picked every 2 to 3 days since the small cucumbers get the best prices. Most of the cucumbers are sold to processing plants under contract agreements.

Sweet potatoes are grown in a few areas of the state on a relatively large scale. The town of Vardaman claims to be "The Sweet Potato Capital of the World." Sweet potatoes are grown from "slips" or shoots which sprout from seed potatoes. Slips are transplanted into the field from March 20 to April 15. A well prepared sandy soil is best for the crop. Special harvesters dig the sweet potatoes from the soil in the fall. They are then washed and placed in crates according to size. They can be sold as fresh market produce or to a processing plant.
Southern peas, pimento peppers, okra, and other vegetable crops are grown throughout the state under contract to a processor or for sale at farmers' markets. Most of these crops are grown by small farmers who use their families to grow and harvest the crops by hand.

In general, most truck crops are best suited to well-drained sandy soils. Fertilizer requirements and planting dates vary. Weeds are usually controlled by hoeing or cultivation. Most of the crops require some insecticide applications for best results.

H. What is the nature of other crop enterprises in Mississippi?

Several other crops are of minor importance to various parts of the state. Usually only a few producers exist for these crops and most are sold within the local area. Minor crops include:

1. Pecans. The state is the 6th largest producer of pecans in the U.S. In 1978, almost 10 million pounds of nuts were produced. Pecans grow on trees which have a life span of 50 years or longer. Most of the major production is in the southern part of Mississippi.

2. Peaches. In 1978, 83,000 bushels of peaches were produced. Most peach orchards are in north Mississippi.

3. Sorghum. Sorghum is grown for grain and silage
purposes. About 64,000 acres of sorghum were harvested in 1978. Half of these were combined for grain and the other half cut for silage. Production practices are similar to those for corn.

4. Greenhouse and nursery crops. While usually not considered true row crops, plants such as shrubs, trees, flowers, and bedding plants are produced by a few growers scattered throughout the state. Almost 8 million dollars worth of these crops were sold in 1978.

5. Sunflowers. Some farmers are raising sunflowers on a trial basis as a cash crop. No figures on acreage or yields are available but much interest is being expressed in the crop. Sunflowers are harvested with combines for their seeds which are processed to make vegetable oil. They are best suited to Class II and III land. Planting dates range from April to July with harvest coming from August to October. There are some research findings which indicate that sunflowers can be planted as late as July 15 and still mature before frost. This may allow the use of sunflowers in the place of soybeans for double cropping with wheat or other small grains.

I. Summing Up:

Soybeans and cotton are the two most important rowcrops in Mississippi. Sales of products from these
two crops alone account for over 85 percent of all income from the sale of crop products and almost half of the total income from the sale of all farm products. Depending upon prices, soybean sales may exceed cotton sales one year and not the next. For every one acre planted in cotton, however, three acres are planted in soybeans.

Cotton is grown mostly in the Mississippi Delta. It is planted in April and May and picked in September, October and November. Cotton requires good land, high rates of fertilization, and large amounts of herbicides and insecticides for high yields. It is used to produce cotton and paper products, vegetable oil, and livestock feeds.

Soybeans are grown throughout the state. The crop is usually planted in May and June and is ready for harvest by October. Soybeans require fair soils, low amounts of fertilizer, and herbicides for best results. They are processed to produce vegetable oil and livestock feedstuffs.

Rice is the third leading cash crop in the state. It requires a special type of soil which does not allow water to seep through easily. Rice is planted from mid-April to mid-June. Once the seeds come up, the field is flooded with water. Moderate amounts of fertilizer are needed as well as special herbicides to control
weeds. The grain is combined from late August to October and used for human food.

Corn is not a major cash crop in Mississippi. It is grown mostly for use on the farm as livestock feed. It may be cut for silage or harvested for grain. Corn requires good land, high amounts of fertilizer, and herbicide protection. It is usually planted in March and April and is ready for harvest by October or November.

Small grains such as wheat and oats are not major cash crops in Mississippi. Much of the acreage planted to these crops is grazed by cattle and not harvested for grain. Small grains require good to moderately good land, and high amounts of fertilizer. Crops are usually planted in the fall and harvested in the late spring. Some farmers are experimenting with raising soybeans and wheat on the same land during the same year.

Truck crop production, with the exception of watermelon and sweet potato fields, is mostly a small scale enterprise used to earn extra cash by small farmers. Cucumbers, pimento peppers, Southern peas, okra, and other vegetable crops are grown for sale to processors or in local farmers' markets.

Other crops grown for cash sales include sunflowers, pecans, peaches, and greenhouse and nursery crops.

Table 2A on the following page summarizes the more important crop enterprises in Mississippi.
<table>
<thead>
<tr>
<th>CROP</th>
<th>ECONOMIC RANK IN STATE</th>
<th>SUITABLE LAND CLASSES</th>
<th>PLANTING DATES</th>
<th>FERTILIZER REQUIREMENTS</th>
<th>HARVEST DATES</th>
<th>MAJOR USES</th>
<th>OTHER COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>2</td>
<td>I, II</td>
<td>April 10 to May 10</td>
<td>Moderate to High</td>
<td>Oct. 1 to Nov. 30</td>
<td>Fiber Oil Feed-stuffs</td>
<td>Requires extensive insect &amp; weed control programs.</td>
</tr>
<tr>
<td>Soybeans</td>
<td>1</td>
<td>I, II, III</td>
<td>May 1 to June 20</td>
<td>Low</td>
<td>Oct. 1 to Nov. 30</td>
<td>Oil Feed-stuffs</td>
<td>Ranks very close to or exceeds cotton in value and exceeds cotton in acreage planted.</td>
</tr>
<tr>
<td>Rice</td>
<td>3</td>
<td>III, IV, V</td>
<td>April 15 to June 15</td>
<td>Low to Moderate</td>
<td>Aug. 20 to Oct. 20</td>
<td>Human Food</td>
<td>Grown only in Delta region. Requires level, heavy textured soils.</td>
</tr>
<tr>
<td>Small Grain</td>
<td>6</td>
<td>I, II, III</td>
<td>Sept. 15 to Oct. 30</td>
<td>Moderate to High</td>
<td>May 15 to June 15</td>
<td>Human Food Feed-stuffs</td>
<td>Often grown as a second crop or as winter grazing for livestock.</td>
</tr>
<tr>
<td>Truck Crops</td>
<td>4</td>
<td>I, II</td>
<td>Varies</td>
<td>Low to High</td>
<td>Varies</td>
<td>Human Food</td>
<td>Usually require high amounts of labor. Generally grown on small acreages.</td>
</tr>
<tr>
<td>Corn</td>
<td>5</td>
<td>I, II</td>
<td>March 1 to April 15</td>
<td>Moderate to High</td>
<td>Oct. 1 to Nov. 15</td>
<td>Feed-stuffs</td>
<td>Not grown as a cash crop by many farmers. Mostly grown for use on the farm.</td>
</tr>
</tbody>
</table>

*1973 Data
V. HOW MUCH HAVE YOU LEARNED?

A. Fill in the rest.

1. Cottonseed, soybeans, and sunflowers are all processed to make __ g __ b __ l.

2. o a s are the only rowcrop grown in noticeable amounts in every Mississippi county.

3. Farmers have switched from cotton to soybeans because p u n costs are lower.

4. Rice is grown in fields which are flooded to a depth of __ to __ inches.

5. Corn requires high amounts of fertilizers, especially __ f __ g __.

6. Small grains are usually planted in the __ l' and harvested in the __ p __ g.

7. t m n and w e o t e are the only two truck crops usually grown in large fields.

8. A m b is a machine used to harvest soybeans, wheat, sunflowers, rice and sometimes corn.

9. Insecticides are needed to control the boll __ e v __ and the boll __ r __ in cotton crops.

10. Truck crops such as okra, peas, cucumbers, and peppers are usually sold to a r s s plant or at a farmers' m k.
B. Right or wrong. Place a check ( ) by every statement which is wrong.

___ 1. Rice is best suited to Class I and II land.

___ 2. For every 1 acre of cotton, there are 3 acres of soybeans.

___ 3. Corn and cotton require low levels of fertilizer.

___ 4. Soybeans do not require as much fertilizer as cotton.

___ 5. Corn is grown in Mississippi for grain and silage.

___ 6. Vegetable truck crops such as cucumbers and pimento peppers are grown in small plots rather than large fields.

___ 7. Soybeans will never be as important as cotton.

___ 8. All of the wheat and oats grown in Mississippi is combined for grain.

___ 9. Cotton, corn, and rice are the three leading cash crops in Mississippi.

___10. Some farmers are trying to double crop soybeans and wheat.
ACROSS
1. The newest row crop in Mississippi which is grown for oil
6. A crop used to make paper and cloth
7. When two crops are raised on the same field in the same year, the practice is called ______ cropping.
10. A month when corn, cotton, and truck crops are usually planted
11. A crop grown for sale (2 words)
13. A chemical used to control weeds
16. A chemical used to control bugs
17. A truck crop grown in south Mississippi that's good on a hot summer day

DOWN
1. More acres are planted to this crop than to any other.
2. Wheat and rice are used mostly as human ________
3. A crop which likes to stand in water
4. A month when cotton, corn, and soybeans are harvested (Abbreviation)
5. Another name for cotton fibers
8. A planting method where seeds are spread over the entire soil surface.
9. Cucumbers, pimento peppers, peas and other vegetables are often called ________
12. Important nuts in Mississippi.
14. A machine which separates cotton fibers from seeds
15. The major cotton and rice growing area in Mississippi.
UNIT TEST
UNIT 21

True/False. Circle T if the statement is true. Circle F if it is false.

T  F  1. Sorghum and corn are grown because their seeds contain large amounts of vegetable oil.
T  F  2. It usually costs less to produce soybeans than it does to produce cotton.
T  F  3. Rice is not suitable for deep well-drained sandy soils.
T  F  4. Insecticides are chemicals used to control insects.
T  F  5. Corn and cotton are the two most important rowcrops in Mississippi.
T  F  6. Soybeans, corn, and cotton can all be harvested using a combine.
T  F  7. Rice and wheat may be planted by broadcasting.
T  F  8. Corn is usually not grown as a major cash crop in Mississippi.
T  F  9. Small grains are usually harvested in the spring.
T  F 10. Soybeans are grown in every county of the state.

Multiple choice. Place a check by the best answer to each statement or question.

1. Important corps grown in the Mississippi Delta are:
   ___ a. Corn, wheat, and cotton
   ___ b. Cotton, sunflowers, and wheat
   ___ c. Cotton, soybeans, and rice
   ___ d. Truck crops, corn, and cotton.
2. Cotton should be planted in:
   ____ a. March and April
   ____ b. April and May
   ____ c. May and June
   ____ d. June and July

3. A machine used to process cotton into lint and seed is a:
   ____ a. combine
   ____ b. picker
   ____ c. cultivator
   ____ d. gin

4. Cottonseed meal and soybean meal are both used to:
   ____ a. make vegetable oil
   ____ b. make bakery foods
   ____ c. make livestock feed
   ____ d. fertilize crops

5. Two crops which can be raised on the same land in one year are:
   ____ a. Corn and soybeans
   ____ b. Soybeans and wheat
   ____ c. Rice and sunflowers
   ____ d. Cotton and sunflowers

6. Most soybeans are planted from:
   ____ a. March to April
   ____ b. April to May
   ____ c. May to June
   ____ d. June to July

7. The normal depth of the water in a rice field is:
   ____ a. 1 to 2 inches
   ____ b. 3 to 4 inches
   ____ c. 7 to 9 inches
   ____ d. 12 to 18 inches

8. Weeds are usually controlled in row crops by:
   ____ a. Using herbicides alone
   ____ b. Using insecticides and herbicides together
   ____ c. Using herbicides and cultivation
   ____ d. Using insecticides and fertilizers
9. Class I and II land is suitable for any row crop except:
   
   ____ a. Rice
   ____ b. Sorghum
   ____ c. Corn
   ____ d. Cotton

10. Two crops which are grown by similar practices are:
   
   ____ a. Corn and small grains
   ____ b. Cotton and rice
   ____ c. Sorghum and corn
   ____ d. Watermelons and sweet potatoes
Name ________________________________

PRETEST
UNIT 23

This test is designed to see how much you already know about the topic of this unit. It will not count as a grade.

Multiple Choice. Place a check by the best answer to each statement or question.

1. One factor which can be used to help a farmer decide on which crops to grow is:
   ___ a. Germination level
   ___ b. Production costs
   ___ c. MCES
   ___ d. Lodging

2. Two government organizations which provide information to farmers about varieties and crops are:
   ___ a. FMHA and HUD
   ___ b. 4H and FFA
   ___ c. FLB and PCA
   ___ d. MAFES and MCES

3. Seed which are certified by the Mississippi Seed Improvement Association can be recognized by a:
   ___ a. Blue tag
   ___ b. White ribbon
   ___ c. Yellow label
   ___ d. Special odor

4. One way in which a farmer can estimate the price of a crop at some time during the coming year is to use the:
   ___ a. MCES Bulletin
   ___ b. Stock Market
   ___ c. Futures Market
   ___ d. Least Significant Difference

5. The germination level of a batch of seed refers to:
   ___ a. The percentage of seed that can be expected to sprout
   ___ b. The amount of weed seed and other crop seed
   ___ c. The number of germs and bacteria present in the seed
   ___ d. The amount of vigor the seed possess
6. In a variety test, the amount of yield which is required for a noticeable difference to exist between two varieties is called:
   ___ a. The least significant difference
   ___ b. The vigor level
   ___ c. The difference of averages
   ___ d. The capability level

7. Seed which meet the minimum requirements of state law are called:
   ___ a. Pure Seed
   ___ b. Approved Seed
   ___ c. Resistant Seed
   ___ d. Blue Ribbon Seed

8. One factor which can be used to help select a variety of a crop is:
   ___ a. Purity
   ___ b. Vigor
   ___ c. Yield
   ___ d. Germination level

9. The law of supply and demand affects market outlook because:
   ___ a. The more plentiful the supply of a crop is, the higher the price will be.
   ___ b. Demand causes prices to remain the same.
   ___ c. An increase in supply causes prices to rise.
   ___ d. As demand increases, prices rise.

10. Seed which produce plants which are true to the characteristics of the variety they possess are said to be:
    ___ a. Vigorous
    ___ b. Resistant
    ___ c. Genetically pure
    ___ d. Weed free

True/False. Circle T if the statement is true and F if it is false.

T  F  1. Bulletins and pamphlets produced by seed companies are usually the most reliable sources of information concerning new varieties.

T  F  2. The length of time required for a plant variety to grow from a seedling to a mature plant is an important factor to consider when selecting a variety.
T  F  3. There can be a difference between certified seed and approved seed.

T  F  4. Lodging occurs when plants fall to the ground before harvest.

T  F  5. The Mississippi Cooperative Extension Service conducts variety tests on crop varieties.

T  F  6. The agency responsible for testing seed to determine germination levels and purities is the Mississippi Agriculture and Forestry Experiment Station.

T  F  7. Disease resistance by a crop variety is important in selection only if a disease is known to exist in a community.

T  F  8. Materials in seed batches such as stems, rocks and broken seed are called inert materials.

T  F  9. The USDA Crop Reporting Service is responsible for publishing crop forecasts and outlooks which can be used to predict supply and demand.

T  F 10. To calculate the pure live seed level in a given batch, one should multiply the germination level times the purity level.
INDEPENDENT STUDY UNITS FOR BASIC VOCATIONAL AGRICULTURE

UNIT 23

PLANT SELECTION

COMPILED BY:
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October 1980
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</table>
I. WHAT'S UP?

Selecting crops and seed is different from selecting cows and pigs. Once a farmer has decided upon a breed of cattle or swine, the remaining task is mainly to find the best animals possible and begin to breed them. Unless the farmer decides to sell out and start over from the beginning, these animals are used for several years and gradually replaced with others of the same breed. A soybean farmer this year however, may switch from one variety to another next year or even become a sunflower and cotton producer. A rowcrop farmer must make decisions on which crops to grow and which varieties to plant every year.

This lesson is intended to help develop your ability to select a crop enterprise, a variety of this crop, and seed for that variety.

II. YOUR OBJECTIVE:

In order to complete this lesson successfully, you must be able to define new terms, describe general factors to be considered when selecting a crop and a variety of a crop, and identify sources of information including government agencies which you can use in making decisions. You must be able to identify the factors to consider in selecting seed of a given variety and select a source of seed when given a specific set of conditions and characteristics. In order to successfully complete
this lesson, you must complete the student assignment and make 70 points on a 100 point lesson test.

III. REACHING YOUR OBJECTIVES:

In order to meet your objectives, you should follow these steps:

A. Carefully read the material on the following pages labeled FYI (For Your Information). All of the information that you need to pass the test is found in this section of the lesson. Read it carefully and ask your teacher to explain anything you cannot understand.

B. After understanding the FYI section, complete the "How Much Have You Learned?" section of the lesson. You will find word completion games, questions, and sample problems which must be answered. Try to complete this section without referring to FYI, but if you get stumped, it's OK to turn back and review. When you think you have all your answers right, have your teacher check them for you.

C. After completing the "How Much Have You Learned" activities, ask your teacher for a copy of the Student Assignment. Remember that the assignment will be graded. It must be completed in class without help from your instructor. You may refer to FYI for help in working the assignment. All work must be done in class.

D. When you think that you are ready for the lesson test, ask your teacher. Remember that once you get the test,
you have to finish it before the end of the class period.
You cannot work part today and finish tomorrow. You must
do all work by yourself, without notes, and in the
classroom.
IV. FYI (FOR YOUR INFORMATION)

A. New terms and definitions

1. Crop variety - A group of plants within a species which has characteristics which make it different from other plants in the same species. Examples: Bragg and Forrest soybeans, Deltapine 45A and Coker 310 cotton, or Funks G5945 and Pioneer 511A corn.

2. Species - A group of plants which have a specific set of readily identifiable characteristics. Corn, cotton, rice and soybeans are all different species of plants.

3. Approved seed - Seed which have met the minimum requirements established by state law. All seed offered for sale must be approved.

4. Certified seed - Seed which have met the requirements of Mississippi Seed Improvement Association. All certified seed meet requirements equal to or greater than those for approved seed.

B. What factors should be considered in selecting a crop enterprise?

The soybean or cotton grower is faced with a decision usually not offered to the beef or hog farmer. The same land may be capable of growing corn, soybeans, sunflowers, or cotton. Usually a beef producer is stuck with beef cattle and cannot easily switch to hogs or chickens from one year to the next. The crop producer
may be able to switch. Several factors must be considered in making a decision on which crops to grow next year. Some of these factors include:

1. Land capability. As you already know, Class I and II lands can profitably produce corn, cotton, soybeans, sunflowers, and several other crops. Class III land is best used for soybeans, small grains, and in some cases rice. The capability of the soil must be considered in deciding which crops are to be grown.

2. Market outlook. The price of a given crop product can vary from week to week. Many different factors such as the number of acres planted throughout the nation, amount of rainfall, government restrictions, and even international politics affect the prices paid to farmers. Most of these factors relate directly to the law of supply and demand. In general this law states that the more abundant the supply of a given item, the lower the price will be; and that the greater the demand for the item, the higher the price will be.

While you cannot buy a crystal ball to tell what prices will be in six months or a year from now, there are some indicators which will help to forecast prices. The United States Department of Agriculture (USDA) Crop Reporting Service issues forecasts and outlooks from time to time for most major crops. The
Chicago Board of Trade operates a Futures Market which is useful in establishing prices expected at various times during the coming year. Most farm publications such as the Progressive Farmer and Farm Journal, as well as newspapers, print articles predicting future supply and demand trends. Usually the local county agent, co-op owner, and vocational agriculture teacher will be willing to share information available to them with a producer.

3. Production costs. The costs of producing one crop when compared to the costs of producing another crop can serve as a decision-making factor. One of the reasons why some producers have switched from cotton to soybeans is that soybeans cost less to produce than cotton. Not only do soybeans require lower amounts of fertilizer than cotton, but also few, if any, insecticide treatments are needed. In some cases, seedbed preparation costs for soybeans are lower. As a result while income from soybean sales does not equal that of cotton, the lower production costs will still allow farmers to return a profit.

4. Machinery requirements. Another factor to be considered in choosing a crop for the coming year is the machinery needed to grow and harvest the crop. Soybeans and sunflowers for, instance, require generally similar equipment. The same combine that
harvests soybeans can also be used to harvest rice, small grains, grain sorghum, and sunflowers. A cotton and soybean grower who owns a worn out cotton picker may decide to plant only soybeans next year to avoid buying a new picker or repairing an old one.

5. Local experiences. In many cases, the decision to plant the same crop this year that was planted last year or to plant a new crop is based upon the experiences of the farmer and nearby neighbors. If Farmer Brown grew soybeans last year and made a profit, then soybeans will probably be planted on the Brown farm again this year. If Brown lost money on soybeans last year and Farmer Smith made money on cotton, then Brown will be more likely to switch to cotton.

C. What general factors should be considered in selecting a variety of a crop?

Once a farmer has decided which crop to grow, a variety of that crop must be selected. This decision may be more difficult than picking a crop. For most crops there will be several possible varieties which can be purchased from local seed dealers. Depending upon local conditions, one variety may be best suited for one field and another variety may be best suited to a second field. Also, the seed companies continue to improve their products by introducing new varieties from year to year.
Most farmers consider the following factors in selecting a variety:

1. **Yield.** The amount of yield a variety produces is a major factor in selection. A grower should be cautious in selecting a variety based upon yield alone, however. A high-yielding variety may not be as resistant to diseases or insects as a variety which yields less. When picking a variety on the basis of test crop yields, a person should remember that these yields are approximate. Under actual field conditions a variety may yield more or less than it does in the tests. Usually when several varieties are tested, a figure called a LSD (Least Significant Difference) is computed by the people conducting the test. The LSD is the amount of yield which is required for a noticeable difference to exist between two varieties. For example, suppose variety A yields 83 bushels per acre, variety B yields 78 bushels per acre, and variety C yields 70 bushels per acre. The LSD is 7 bushels per acre. The difference between varieties A and B is 5 bushels, between B and C is 8 bushels, and between A and C is 13 bushels. Since the difference between varieties A and B is less than the LSD (7), varieties A and B could be expected to yield about the same. Variety C could be expected to yield less than
either A or B, because the difference between variety C and varieties A and B are more than 7.

2. Disease and insect resistance. Plant diseases and insects may reduce crop yields each year. The producers of crop varieties try to correct this problem by creating new varieties which either resist these problems or are better able to tolerate their effects. Resistance to nematodes is particularly important for many crops. Nematodes are very small worm-like animals which live in the soil and damage plant roots.

Diseases are only a problem if they attack a plant to the extent that damages occur. Since some disease resistant varieties do not yield as much as other varieties, a grower should talk to others to see if diseases or nematodes are present in the community. The Plant Pathology Department of the Mississippi Cooperative Extension Service (MCES) can make tests on soil samples to determine if nematodes are present in the soil.

3. Lodging. Lodging refers to the percentage of plants which fall to the ground during the growing season. Since most crops are harvested by machines, the stalks of the plants must remain upright. If the plant is lying on the ground, the combine or picker may not be able to harvest it. Also the grain or
lint is more likely to rot from contact with the ground.

4. Planting and maturity dates. The length of time required for a crop variety to go from a seed to a plant ready for harvesting is highly important. If the crop will not be planted until later in the season, certain varieties which require less time to mature may be the best choice. Soybeans, which are sensitive to the number of hours of daylight, are one crop in particular that may require attention to variety selection when planted at certain times of the spring.

The factors mentioned above are general factors to be considered in selecting varieties for all crops. Specific factors usually apply to specific crops in addition to these general factors.

D. Where can information on different varieties be obtained?

In order to select a variety, a farmer or grower must have current information and be able to correctly understand what this information says about different varieties. Information can be obtained from several different sources including:

1. MAFES. The Mississippi Agricultural and Forestry Experiment Station (MAFES) conducts variety tests for most major crops at experiment stations throughout
the state. Each test involves growing different varieties in several small plots. These plots are harvested and the per acre yield of each variety is determined. Data on other selection factors such as disease resistance, lodging, and maturity dates are also recorded. Results of these tests are printed in the monthly newspaper MAFES Research Highlights and in special bulletins. Both the newspaper and bulletins are available to Mississippi residents at no charge. For a free subscription and list of available bulletins write to: MAFES Editorial Department, P.O. Box 5168, Mississippi State, MS 39762. Ask specifically for a subscription to MAFES Research Highlights and a list of available bulletins.

2. MCES. The Mississippi Cooperative Extension Service (MCES) provides information on almost all crops grown in Mississippi. MCES recommendations are based upon MAFES tests and research conducted in other states. Usually MCES bulletins are easier to understand than the MAFES publications. Most bulletins can be obtained from the local county agent's office.

3. Farm magazines. Magazines such as Progressive Farmer and Farm Journal may print articles from time to time concerning new varieties or providing specific
4. Seed companies and local dealers. Information about different varieties is usually available at local dealers. When using this information, one should be cautious since usually a pamphlet or brochure picked up at a local supply house may be designed to sell the varieties which the supplier has in stock.

E. What factors should be considered in selecting seed of a given variety?

Once a specific variety of a crop has been selected, a farmer must purchase high quality seed for planting. This is one step in the production process where it pays not to economize by buying cheap seed. The best seed available should be planted. All seed sold in Mississippi must be tested and approved as meeting minimum requirements set by state law. Seed which meet the requirements of the Mississippi Seed Improvement Association are certified seed. These seed come from inspected fields and meet or exceed the minimum requirements of state law. Certified seed can be recognized by an official blue tag which is printed by the Association. Information on this tag is determined by official tests conducted by the Association. An example of a tag is shown in Figure 23A. All certified seed meet the requirements for approved seed but not all approved seed can be certified.
**Figure 23A**

Sample Seed Label

<table>
<thead>
<tr>
<th>CERTIFIED SEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>CROP</td>
</tr>
<tr>
<td>VARIETY</td>
</tr>
<tr>
<td>LOT NO.</td>
</tr>
<tr>
<td>NT. WT. LBS.</td>
</tr>
<tr>
<td>JOE SMITH SEED COMPANY</td>
</tr>
<tr>
<td>BENT FORK, MS</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

The container bearing this label when properly tagged under the regulations of the Mississippi Seed Improvement Association, contains the class of Mississippi Certified Seed as shown on this label.

*MEMBER OF ASSOCIATION OF OFFICIAL SEED CERTIFYING AGENCIES*
In selecting seed for a given variety, the following factors should be considered:

1. Genetic purity. The seed purchased should produce plants which are true to the variety characteristics they represent. Any seed certified by the Mississippi Seed Improvement Association can be assumed to be genetically pure.

2. Mechanical purity. Seed should be as free as possible of impurities such as weed seed, other crop seed and inert materials. Inert materials include stems, rocks, and broken seeds. The certified seed tag will give the mechanical purity of the seed in percentages. For example, a seed batch which has a 95 percent purity level might contain 1 percent crop seed, 3 percent inert matter, and 1 percent weed seed. Certain weeds are officially called noxious weeds. No noxious weeds are allowed in approved or certified seed.

3. Germination level. This term refers to the percentage of seed which can be expected to sprout and begin to grow. A 90 percent germination level means that 90 seeds from every 100 seeds will sprout and begin to grow. In general, buyers should look for seeds with high germination levels.

4. Vigor. Seed to be planted need to have vigor or the ability to grow rapidly under a variety of conditions. There is no official test for vigor and
no information can be found on a label which indicates vigor.

All seed offered for sale must be tested and approved by the Mississippi Seed Testing Laboratory. A tag which shows the germination and purity level must be attached to the bag in which the seed are sold. The tag must also show the name of the producer, the name of the crop and variety, and the date the seeds were tested.

It is wise not to buy any seed which have not been tested in the past 12 months.

F. How can the information on a seed tag be used to select seed?

In selecting seed, price alone is a poor guide. The cheapest seed are not always the poorest and the most expensive are not always the best. Quality of a batch of seed is determined by the amount of pure live seed present. To determine the pure live seed level multiply the percentage germination level times the percentage purity level. Convert both percentages to hundredths before multiplying (90% = .90; 85% = .85; etc.) The pure live seed level is then divided into the price of the seed to determine the true cost of the seed. These two computational procedures can be written as simple formulas:

1. Pure live seed level = germination x purity
2. true cost = \[
\frac{\text{Price}}{\text{Pure live seed level}}
\]
For example, suppose a batch of corn seed has a germination level of 96% and a purity level of 98%. The seed cost $9.00 per bushel. The pure live seed level of the batch would equal .96 times .98 or .9408%. True cost of 1 bushel of pure live seed would be equal to $9.00 divided by .9408 or $9.57 (approximately).

Suppose the farmer can buy seed from another dealer of the same variety. These seed have a germination level of 94% and a purity level of 97%. Price of these seed is $8.75 per bushel. The pure live seed level would be .94 \times .97 = .9118\%. True cost of 1 bushel of pure live seed would be $8.75 divided by .9118 = $9.60 per bushel (approximately). The less expensive seed actually cost more since their purity and germination levels are lower. Calculations for these figures are shown in Figure 23B.

G. Summing Up

Selecting crops, varieties, and seed is, in some respects, more complicated than selecting animals such as cows or hogs. A person cannot judge seeds by looking at them as one judges a steer or a heifer. When deciding on which crops to grow, a producer must consider land capability, market outlook, production costs, machinery requirements, and local experiences. In selecting a variety of a crop, factors such as yield, insect and
**FIGURE 23B**

**Calculation of True Seed Cost**

<table>
<thead>
<tr>
<th>Germination Level - 96%</th>
<th>Germination Level - 94%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purity Level - 98%</td>
<td>Purity Level - 97%</td>
</tr>
<tr>
<td>Cost - $9.00 per bushel</td>
<td>Cost - $8.50 per bushel</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pure Live Seed Level</th>
<th>.96</th>
<th>Pure Live Seed Level</th>
<th>.94</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>x .98</td>
<td></td>
<td>x .97</td>
</tr>
<tr>
<td></td>
<td>768</td>
<td></td>
<td>658</td>
</tr>
<tr>
<td></td>
<td>864</td>
<td></td>
<td>846</td>
</tr>
<tr>
<td></td>
<td>.9408</td>
<td></td>
<td>.9118</td>
</tr>
</tbody>
</table>

True Cost

\[
\frac{.9408}{9.0000 \times 00} = \frac{9.566}{9.57}
\]

<table>
<thead>
<tr>
<th>84672</th>
<th>9.321 = $9.32</th>
</tr>
</thead>
<tbody>
<tr>
<td>53280</td>
<td>59520</td>
</tr>
<tr>
<td>47040</td>
<td>56448</td>
</tr>
<tr>
<td>62400</td>
<td>56448</td>
</tr>
<tr>
<td>27354</td>
<td>27354</td>
</tr>
<tr>
<td>19260</td>
<td>19260</td>
</tr>
<tr>
<td>82062</td>
<td>82062</td>
</tr>
<tr>
<td>29380</td>
<td>29380</td>
</tr>
<tr>
<td>18236</td>
<td>18236</td>
</tr>
<tr>
<td>9240</td>
<td>9240</td>
</tr>
<tr>
<td>9118</td>
<td>9118</td>
</tr>
<tr>
<td>122</td>
<td>122</td>
</tr>
</tbody>
</table>
disease resistance, lodging, and planting and maturity
dates must be determined. Information for making both of
these decisions can be obtained from MAFES (Mississippi
Agricultural and Forestry Experiment Station), MCES
(Mississippi Cooperative Extension Service), farm
magazines, and local seed dealers. Producers should use
as many sources of information as possible in reaching a
decision.

In selecting seed for a given variety, the
information on the seed tag should be evaluated. The
purity level and germination level should be used to
determine the amount of pure live seed present. Based
upon the pure live seed level and the price of
the crop, a producer can select the best seed.
V. WHAT HAVE YOU LEARNED?

A. Fill in the rest.

1. The c________t of the soil must be considered in deciding what crops are to be grown.

2. In selecting a variety based upon yields, the l______t s______f______ d______r______ is the amount of yield which is required for a noticeable difference to exist between two varieties.

3. Seed which have been certified by the Mississippi Seed Improvement Association can be recognized by an official ______a____.

4. The percentage of pure live seed is found by multiplying the g______n______ percentage times the ______u______v percentage.

5. Some varieties may be more s______t______ to insects and diseases than other varieties.

6. A ______v______ is a group of plants within a given species which has characteristics which set it apart from other plants in the same species.

7. L______ is said to occur when plants fall to the ground before harvest.

8. ______n______ p______r______ refers to the ability of seed to produce plants which are true to the variety characteristics they represent.

9. Plant stems, rocks, and pieces of broken seed are labeled ______t______ t______e______ s______ on a seed tag.
10. The **M**arket operated by the Chicago Board of Trade can provide an estimate of crop prices at various times during the coming year.

B. Right or wrong.

Place a check ( ) by every statement which is wrong.

___ 1. Machinery requirements are an important consideration in selecting a crop.

___ 2. When a farmer makes a profit from one crop this year, he or she is more likely to grow that same crop next year.

___ 3. All seeds which are approved as meeting minimum requirements of the state law can be certified.

___ 4. Germination level refers to the percentage of weed seed and inert material in a seed bag.

___ 5. Usually the most expensive seed a farmer can buy are the best seed.

___ 6. A farmer or grower should be wary of bulletins describing variety yields which are produced by seed companies.

___ 7. Seeds which are certified by the Mississippi Seed Improvement Association meet or exceed the minimum requirements of state law.

___ 8. A producer should consider production costs as well as income when selecting a crop to plant.

___ 9. Usually the same variety of soybeans which can be planted early in the season, will be the best variety
to plant late in the season.

10. Bulletins from the Mississippi Cooperative Extension Service are usually available at the local county agent's office.

C. Figure it out. (Show all work in the space provided.)

1. Jane Shows is planning to grow 5 acres of corn to feed to her hogs. Based upon tests conducted by MAFES, she has picked three varieties which would meet her requirements. Variety A averaged 78 bushels per acre in test. Variety B averaged 74 bushels per acre and Variety C averaged 70 bushels per acre. If the LSD for the test yields is 5 bushels, is there a difference between the yields of:
   a. Variety A and variety B?
      ____ Yes  ____ No
   b. Variety A and variety C?
      ____ Yes  ____ No
   c. Variety B and variety C?
      ____ Yes  ____ No

2. According to the official tag on the seed bag, the germination level of a certain batch of rice seed is 90% and the purity level is 98%. What is the pure live seed level of this batch?
3. If the rice seed above sell for a price of $8.75 per bushel, what is the true cost of one bushel of pure live seed?

4. Another batch of rice seed of the same variety has a germination level of 95% and a purity level of 99%. What is the pure live seed level of this batch?

5. If the seed in problem 4 sell for $10.75 per bushel, what is the true cost of one bushel of pure live seed?
SITUATION #1: A farmer has decided to try a double cropping system using soybeans and wheat during the next year. Based upon information provided by MAFES, the three highest producing varieties for the local area are Forrest, Davis, and Tracey. The farmer knows that cyst nematodes and root knot nematodes are a problem in the field. In order to plant wheat in the fall, the farmer needs to harvest the soybeans as early as possible. Based upon the information given below, circle the name of the variety best suited to this situation. List at least two reasons why you picked this variety at the bottom of this page.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Davis</td>
</tr>
<tr>
<td>Yield (LSD = 6 Bu.)</td>
<td>37.4 bu/A</td>
</tr>
<tr>
<td>Planting Date</td>
<td>May 15-June 15</td>
</tr>
<tr>
<td>Maturity Date</td>
<td>October 14</td>
</tr>
<tr>
<td>Shatter Resistance*</td>
<td>Fair</td>
</tr>
<tr>
<td>Cyst Nematode Resistance</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Root Knot Nematode</td>
<td>Susceptible</td>
</tr>
</tbody>
</table>

*Shatter Resistance is a property of soybeans which refers to the ability of the bean pods to hold the seed until the combine can harvest them.

Reason 1. ___________________________________________________________

Reason 2. ___________________________________________________________
Situation #2: After reaching a decision on which variety to plant, the farmer looked for seed of that variety. Both local seed suppliers had seed. Using the information below, which source is the better buy?

<table>
<thead>
<tr>
<th></th>
<th>Seed #1</th>
<th>Seed #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination</td>
<td>80%</td>
<td>90%</td>
</tr>
<tr>
<td>Purity</td>
<td>98%</td>
<td>99%</td>
</tr>
<tr>
<td>Weed seed</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Inert</td>
<td>2%</td>
<td>1%</td>
</tr>
<tr>
<td>Noxious weeds</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Net. wt. lbs.</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Cost</td>
<td>$14.70 per bu.</td>
<td>$15.50 per bu.</td>
</tr>
</tbody>
</table>

Compute on the back of this sheet the pure live seed level of each batch and the true cost per bushel. Write your answers in the spaces below.

Seed #1

Pure live seed level

True cost

Seed #2

Pure live seed level

True cost
UNIT TEST
UNIT 23

Multiple Choice. Place a check by the best answer to each statement or question.

1. One source of information about crop varieties which may not be as reliable as other sources is:
   ___ a. MAFES Research Highlights
   ___ b. MCES Bulletins
   ___ c. USDA Pamphlets
   ___ d. Seed Company Brochures

2. Certified seed must meet all requirements of the:
   ___ a. Mississippi Agriculture and Forestry Experiment Station
   ___ b. Mississippi Seed Improvement Association
   ___ c. Mississippi Cooperative Extension Service
   ___ d. United States Department of Agriculture

3. The state agency responsible for conducting variety tests is:
   ___ a. MAFES
   ___ b. MCES
   ___ c. MFFA
   ___ d. USDA

4. The term used by farmers when plants fall to the ground before they can be harvested is:
   ___ a. Root-rot
   ___ b. Loss of Vigor
   ___ c. Lodging
   ___ d. Lack of Resistance

5. Examples of inert materials which can be found in seed batches include:
   ___ a. Rocks, stems, and broken seed
   ___ b. Other crop seed
   ___ c. Weed seed
   ___ d. Seed which will not germinate
6. The state agency responsible for testing seed is:
   ___ a. Cooperative Extension Service
   ___ b. Agricultural Experiment Station
   ___ c. Seed Testing Laboratory
   ___ d. Department of Agriculture

7. An agency which issues crop outlooks and forecasts is:
   ___ a. Farm Forecast Bureau
   ___ b. Agricultural Experiment Station
   ___ c. Seed Testing Laboratory
   ___ d. United States Department of Agriculture

8. To calculate the level of pure live seed in a given batch, you should multiply:
   ___ a. Germination level times purity level
   ___ b. Least significant difference times purity level
   ___ c. Mechanical purity times genetic purity
   ___ d. Moisture level times weight of seed

9. If nematodes are known to exist in a given soil, a producer should pay close attention to a variety's:
   ___ a. Lodging ability
   ___ b. Disease resistance ability
   ___ c. Germination level
   ___ d. Maturity date

10. When a crop must be planted late in the planting season, a producer should pay close attention to:
    ___ a. Disease resistance
    ___ b. Maturity date
    ___ c. Purity
    ___ d. Least significant difference

True/False. Circle T if the statement is true. Circle F if it is false.

   T   F  1. Production costs as well as expected income must be considered in selecting a crop.

   T   F  2. Seed which have been certified by the Mississippi Seed Improvement Association can be recognized by an official blue ribbon.

   T   F  3. Usually as the demand for a given crop increases, the price of the crop will decrease.
T  F  4. Seed which produce crops which are true to the characteristics of the variety they represent are said to be genetically pure.

T  F  5. MAFES and MCES are two agencies which provide information to use in selecting varieties.

T  F  6. The Futures Market is one way a farmer can estimate what crop prices will be at harvest time.

T  F  7. The least significant difference refers to the amount of seeds which can be expected to grow in a variety test.

T  F  8. Approved seed must meet all requirements of state law.

T  F  9. The germination level of a batch of seed refers to the number of germs and bacteria on the seed.

T  F 10. The amount a variety will yield is a major factor in the selection process.
This test is designed to see how much you already know about the topic of this unit. It will not count as a grade.

Multiple Choice. Place a check by the best answer to each statement or question.

1. The basic chemical elements and compounds which provide the raw materials for plant growth are called:
   - a. Organic fertilizers
   - b. Limes
   - c. Plant nutrients
   - d. Ureas

2. Most crops in Mississippi grow best in a soil pH of:
   - a. 4.5 to 5.5
   - b. 5.0 to 6.0
   - c. 6.0 to 7.0
   - d. 6.5 to 8.0

3. A common source of nitrogen is:
   - a. Basic Slag
   - b. Urea
   - c. Super Phosphate
   - d. Muriate of Potash

4. The practice of adding fertilizer beside the roots of growing plants is called:
   - a. Top Dressing
   - b. Side Dressing
   - c. Broadcasting
   - d. Middle-busting

5. The main liming material used in Mississippi is:
   - a. Soft Calcitic Lime
   - b. Muriate of Potash
   - c. Ammonium Sulfate
   - d. Triple Super Phosphate
6. The three major plant nutrients are:
   ____ a. Carbon, Calcium, and Sulfur
   ____ b. Water, Sunlight, and Fertilizer
   ____ c. Nitrogen, Phosphate, and Potash
   ____ d. Phosphate, Magnesium, and Calcium

7. If a fertilizer contains 10% phosphate, 5% nitrogen, and 15% potash, its analysis would be:
   ____ a. 10-5-15
   ____ b. 5-10-15
   ____ c. 15-10-5
   ____ d. 15-5-10

8. The best time to apply nitrogen fertilizer is:
   ____ a. In the fall before spring planting
   ____ b. In the winter before spring planting
   ____ c. Four weeks before planting
   ____ d. At the time of planting

9. Anhydrous ammonia is most commonly applied by:
   ____ a. Broadcasting
   ____ b. Liquid Injection
   ____ c. Top Dressing
   ____ d. Banding

10. As pH decreases, the amount of acid in the soil:
    ____ a. Increases
    ____ b. Decreases
    ____ c. Remains the same
    ____ d. Becomes weaker

True/False. Circle T if the statement is true. Circle F if it is false.

T  F  1. Inorganic fertilizers are produced by man-made processes.

T  F  2. One important function of potassium is to make stalks stiffer and help prevent lodging.

T  F  3. Zinc, boron, and molybdenum are minor nutrients which may be lacking in some soils.

T  F  4. Nitrogen gives plants their dark green color and causes rapid growth.
T  F  5. Lime is applied to soil mainly for the purpose of speeding up root formation in certain plants.

T  F  6. Drop type fertilizer distributors and spin spreaders are used to band fertilizer.

T  F  7. It usually takes three months for lime to react within the soil.

T  F  8. As soil pH decreases below 5.5, plant nutrients become harder to get.

T  F  9. A complete fertilizer must contain nitrogen, phosphate, and calcium.

T  F  10. Basic slag is a complete fertilizer.
Unit 25

Plant Nutrients and Fertilizers

Student Name: _______________
Class: ________________________
School: _______________________
INDEPENDENT STUDY UNITS FOR BASIC VOCATIONAL AGRICULTURE

UNIT 25

PLANT NUTRIENTS AND FERTILIZERS

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Individualized Instruction Unit No. 25

PLANT NUTRIENTS AND FERTILIZERS

I. WHAT'S UP?

Every plant producer in Mississippi from the house plant grower to the plantation owner understands the importance of using fertilizer to help plants grow. Each year millions of tons of chemical fertilizers are spread on thousands of acres throughout the state. The price of fertilizer has risen in the past few years like the cost of all other farm supplies. This increase in costs has caused many producers to look for new ways to apply fertilizer in more economical manners. Also most farmers are now trying to find the right amount of fertilizer—an amount that will supply just enough nutrients for best growth without providing too much.

This lesson is intended to develop your knowledge of the nutrients plants need and the materials and methods used to provide these nutrients.

II. YOUR OBJECTIVE:

When you finish this lesson, you should be able to define some new terms, list the major and minor plant nutrients and describe their purposes, and describe the relationship between pH and soil fertility. You should also be able to describe how fertilizer is graded, name sources of the three major nutrients, and describe the ways fertilizer is applied. Finally, you should be able to discuss when fertilizer should be applied and to determine the true costs of plant nutrients. In order to successfully complete this lesson, you must complete the student assignment and make 70 points on a 100
point lesson test.

III. MEETING YOUR OBJECTIVES:

In order to meet the objectives above you should follow these steps:

A. Carefully read the material on the following pages labeled F.Y.I. (For Your Information). It contains all of the information you need to pass the test. Read it carefully and ask your teacher to explain anything which you cannot understand.

B. After you have carefully read FYI, complete the "How Much Have You Learned?" section of this lesson. You will find a crossword puzzle, word completion games, and several questions which must be answered. Try to complete each exercise without referring to FYI, but if you cannot remember everything turn back. When you think that all of your answers are correct, ask your teacher to check them.

C. When you have completed the "How Much Have You Learned" activities ask your teacher for a copy of the Student Assignment. Remember that the assignment will be graded. It must be completed in class without help from your instructor. You may refer back to FYI for help.

D. When you think that you are ready to take the lesson test, ask your teacher. Remember that once you get the test, you have to finish it before the end of the class period. You cannot work part today and finish tomorrow. You must do all work by yourself, without notes, and in the classroom.
V. F.Y.I. (FOR YOUR INFORMATION):

A. New terms and definitions

1. Plant nutrients - Basic chemical elements which provide the raw materials for plant growth.

2. Organic fertilizer - Any material which contains noticeable amounts of plant nutrients and is the result of natural processes of decay. Manure is the major organic fertilizer still used on farms today.

3. Inorganic fertilizer - (Also called chemical fertilizer) Any material used to supply nutrients to plants which is produced by mining or man-made processes.

4. Soil fertility - The relative ability of a soil to provide nutrients needed by plants.

B. What are the major plant nutrients and their function?

Most of the nutrients needed by plants are supplied naturally by the air and by water. Three nutrients are usually supplied to plants by chemical fertilizers in large amounts. These nutrients and their functions are:

1. Nitrogen. Nitrogen gives plants their dark green color and causes rapid growth. It increases yields and increasing the protein content of food and fed crops.

2. Phosphorus. Phosphorus or phosphate as it is commonly called helps speed up root formation and growth. It gives plants a rapid and vigorous start and is very important to germinating seedlings. Phosphate
stimulates blooming and speeds up maturity and seed formation.

3. Potassium. Potassium or potash as most producers call this nutrient is partially responsible for giving plants vigor and disease resistance and making stalks stiffer. This helps reduce lodging. Potash increases the plumpness of grain and seeds and is needed before plants can properly manufacture starches, sugars, and oils which give plants their nutritional content.

C. What are the minor nutrients required by plants and their functions?

There are a number of nutrients which are required by plants in small amounts. Under most normal conditions, these elements are available from the soil without having to be added by the farmer or grower. Calcium, magnesium, and sulfur are classified as secondary nutrients since they are required in moderate amounts. Zinc, boron, and molybdenum, are micronutrients. These elements are required in very small amounts and may need to be added in some cases to certain soils. The functions of these minor nutrients are discussed below:

1. Calcium. This element promotes root formation and growth and improves general plant vigor. Calcium influences the uptake of other nutrients by the plant. It helps to neutralize poisons to which the plant may be exposed. Calcium is found in plentiful amounts on
well-limed high pH soils.

2. Magnesium. Magnesium is a necessary part of the chemical chlorophyll. This chemical gives leaves their green color. Magnesium is needed to help plants form the sugars that are necessary for growth and to regulate the uptake of other nutrients. A well-limed high pH soil usually supplies all the magnesium most plants need. Some coarse sandy soils and heavy dark clays may be low in magnesium content.

3. Sulfur. Sulfur is an essential ingredient of plant protein, an important nutrient in feeding animals. It helps plants to have their dark green color and encourages rapid growth and seed production. Sulfur is usually plentiful on most soils but may be lacking on coarse sandy soils and on some grasslands.

4. Zinc. Small amounts of zinc are needed for normal growth. Zinc may be lacking on sandy soils with high pH when these soils are used to grow corn, sorghum, or pecans.

5. Boron. Boron also is required in only very small amounts for best growth and yields. Some soils may not supply enough boron for cotton or alfalfa.

6. Molybdenum. This element is necessary for best production of soybeans and clovers. These plants take nitrogen from the air and place it in the soil. Molybdenum is an essential part of this process. Soils which have a pH below 6 may not naturally supply enough of this nutrient for highest yields.
Other micronutrients required for plant growth are iron, manganese, copper, and chlorine. These elements are not lacking for crop production in Mississippi. In some cases they may be used for ornamental plant production.

D. What is the relationship of soil pH to soil fertility?

The pH of a soil is a measure of the amount of acid in the soils. The pH scale is used to measure the concentration of hydrogen ions. The scale ranges from 1 to 14. A pH of 7 indicates a neutral soil. A pH below 7 is said to be acid and above 7 is said to be alkaline. Acid soils are sometimes called "sour" soils while alkaline soils are said to be "sweet."

The pH scale does not have an equal interval between numbers. Each whole number on the scale represents a pH which is ten times greater or smaller than the numbers on either side of it. A pH of 5 for example is ten times more acid than a pH of 6.

REMEMBER: SOILS WHICH HAVE A pH OF LESS THAN 7 ARE ACID. SOILS WHICH HAVE A pH OF MORE THAN 7 ARE ALKALINE.

Almost all soils in Mississippi are slightly acid. They have a pH of 6.5 or less. In some cases, the pH of a soil may be 5.5 or lower. Most crops grown in Mississippi do best in a soil pH of 6.0 to 7.0.

Then the soil pH drops below 5.5, plant growth and yields can be severely reduced. Plant nutrients such as
nitrogen, phosphate, and potash are held in the soil by weak chemical bonds. As the pH of the soil drops, these chemical binding forces become stronger. The nutrients are held so tightly by the soil that it is hard for the roots to remove them and take them into the plant.

Agricultural limestone or lime as it is commonly called is used to raise the pH level of a soil to higher levels. By increasing the pH, availability of nutrients in the soil is usually increased. Lime helps fertilizers reach plants. On heavy soils, it can help the structure of the soil itself by making it more crumbly.

E. What is meant by fertilizer analysis or grade?

Any material sold as fertilizer in Mississippi must be chemically tested and the percentage of nutrients in the material determined. The results of this test must be clearly printed on the package or container in which the fertilizer is sold. The test or analysis is made to determine the amount of nitrogen, phosphate, and potash present. Usually these nutrients are referred to by their chemical abbreviations or N (nitrogen), P (phosphate or phosphorus), and K (potash or potassium).

Nitrogen is measured in terms of the percentage of pure nitrogen present. Phosphate is measured in terms of phosphoric oxide present and potash is analyzed in terms of potassium oxide.

When a fertilizer is labeled 13-13-13, it contains
13% N, 13% P and 13% K. A bag of fertilizer labeled 5-10-15 would contain 5% N, 10% P, and 15% K. The first number in the series always stands for the percentage of nitrogen. The second number represents phosphate and the third number potash. The presence of other minor nutrients such as boron or magnesium will also be indicated on the bag or container.

When a fertilizer contains all three major nutrients, it is called a complete fertilizer. When it contains only one or two of the major nutrients, it is called an incomplete fertilizer.

F. What are the common sources of N, P, K, and lime?

Table 25A shows several sources of the major plant nutrients. The analysis of each source in terms of nitrogen (N), phosphate (P₂O₅), and potash (K₂O) is given. The table also indicates the relative time it takes the material to become available to the plants. Finally, the table classifies each source as being acid forming or base forming. Acid forming materials react within the soils to lower pH. Base forming materials react to raise pH. An asterisk (*) by a source indicates it is one of the more commonly used materials.

Complete fertilizers such as 13-13-13 or 6-8-8 are created by mixing these basic source materials together in the proper amounts.
TABLE 25A
ANALYSIS OF COMMON FERTILIZER MATERIALS

<table>
<thead>
<tr>
<th>Material Supplying</th>
<th>%N</th>
<th>%P₂O₅</th>
<th>%K₂O</th>
<th>Availability</th>
<th>Acid or Base Forming</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nitrogen</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Ammonium nitrate</td>
<td>33.5</td>
<td>0</td>
<td>0</td>
<td>Quick</td>
<td>A</td>
</tr>
<tr>
<td>Calcium nitrate</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>Quick</td>
<td>B</td>
</tr>
<tr>
<td>Cottonseed meal</td>
<td>6.5</td>
<td>2.5</td>
<td>2</td>
<td>Slow</td>
<td>A</td>
</tr>
<tr>
<td>*Nitrate of Soda</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>Quick</td>
<td>B</td>
</tr>
<tr>
<td>Ammonium nitrate Limestone</td>
<td>20.5</td>
<td>0</td>
<td>0</td>
<td>Quick</td>
<td>Neutral</td>
</tr>
<tr>
<td>Nitrogen solutions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Am. nitrate</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>Quick</td>
<td>A</td>
</tr>
<tr>
<td>Urea Am. nitrate</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>Quick</td>
<td>A</td>
</tr>
<tr>
<td>*Anhydrous am.</td>
<td>82</td>
<td>0</td>
<td>0</td>
<td>Quick</td>
<td>A</td>
</tr>
<tr>
<td>Sulphate of am.</td>
<td>21</td>
<td>0</td>
<td>0</td>
<td>Quick</td>
<td>A</td>
</tr>
<tr>
<td>*Urea</td>
<td>46</td>
<td>0</td>
<td>0</td>
<td>Quick</td>
<td>A</td>
</tr>
<tr>
<td><strong>Phosphate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic Slag</td>
<td>0</td>
<td>6-10</td>
<td>0</td>
<td>Quick</td>
<td>B</td>
</tr>
<tr>
<td>Di-Am. phosphate</td>
<td>18</td>
<td>46</td>
<td>0</td>
<td>Quick</td>
<td>B</td>
</tr>
<tr>
<td>Ground Rock phosphate</td>
<td>0</td>
<td>26-35</td>
<td>0</td>
<td>Slow</td>
<td>B</td>
</tr>
<tr>
<td>(3% avail.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monoammonium phosphate</td>
<td>11</td>
<td>48</td>
<td>0</td>
<td>Quick</td>
<td>A</td>
</tr>
<tr>
<td>*Superphosphate</td>
<td>0</td>
<td>18-20</td>
<td>0</td>
<td>Quick</td>
<td>Neutral</td>
</tr>
<tr>
<td>*Triple superphosphate</td>
<td>0</td>
<td>45-50</td>
<td>0</td>
<td>Quick</td>
<td>Neutral</td>
</tr>
<tr>
<td><strong>Potash</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>*Muriate of potash</td>
<td>0</td>
<td>0</td>
<td>60</td>
<td>Quick</td>
<td>Neutral</td>
</tr>
<tr>
<td>Potassium nitrate</td>
<td>13</td>
<td>0</td>
<td>44</td>
<td>Quick</td>
<td>B</td>
</tr>
<tr>
<td>Sulphate of potash</td>
<td>0</td>
<td>0</td>
<td>48-52</td>
<td>Quick</td>
<td>Neutral</td>
</tr>
<tr>
<td>Sulphate of potash magnesia</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>Quick</td>
<td>Neutral</td>
</tr>
<tr>
<td>Wood Ashes</td>
<td>0</td>
<td>2</td>
<td>15-25</td>
<td>Medium</td>
<td></td>
</tr>
</tbody>
</table>

* Most common sources
Liming materials are not usually classified as fertilizers but are referred to as soil amendments. Their chief function is to neutralize soil acid which promotes growth by making other nutrients more available. Table 25B provides information on different sources of lime. The rate at which lime works in the soil is affected by the degree of fineness to which it has been ground. The finer the grind of the lime is; the faster it will neutralize soil acid. The neutralizing value of the materials shown in the table is based upon a comparison of the material to pure calcium carbonate.
TABLE 25B
COMMON LIMING MATERIALS

<table>
<thead>
<tr>
<th>Material</th>
<th>Neutralizing Valve</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Calcitic Lime</td>
<td>90%</td>
<td>Most common and least expensive source in Miss.</td>
</tr>
<tr>
<td>Soft Calcitic Lime</td>
<td>80-85%</td>
<td></td>
</tr>
<tr>
<td>Basic Slag (potash added)</td>
<td>60-75%</td>
<td>Reacts quickly with soil contains phosphate</td>
</tr>
<tr>
<td>Dolomitic Lime</td>
<td>100%</td>
<td>Contains magnesium</td>
</tr>
</tbody>
</table>

G. How are fertilizer and liming materials usually applied?

There are five methods which can be used to apply fertilizer and lime. These five are:

1. Broadcasting. All lime is applied in this manner and there is a growing use of this method for applying phosphate and potash. Broadcasting involves spreading fertilizer or lime at an even rate across the total soil surface. When planting crops, a disk or other tool is used to mix the fertilizer or lime into the soil. For established forage crops the materials are left on top of the ground. A drop type distributor as shown in Figure I or a spin spreader is used to spread the material. Spin spreaders are also mounted on trucks. In some instances fertilizers may be broadcast by airplanes.
FIGURE 25A
FERTILIZER APPLICATION EQUIPMENT

Planter Mounted Band Distributor

Tractor Mounted Spinner Distributor

Drop-type Distributor

Anhydrous Ammonia Injector
2. Banding or sidedressing. Many farmers apply fertilizer to row crops using a band. Banding involves using applicators mounted on the planter to put a strip of fertilizer just below and on either side of the seed. (See Fig. 25A) This band provides fertilizer near the seed without harming the seed. It also keeps the fertilizer out of the row middles where it could encourage weed growth. After crops such as cotton or corn are up and growing, some producers use band applicators mounted on cultivators to sidedress crops. Sidedressing usually involves placing nitrogen fertilizers alongside the roots of the crop.

3. Liquid injection. Some fertilizers are applied in a liquid form by forcing them into the soil. Special plows are used to place these liquids in the soil. The fertilizer is either forced into the soil under pressure or allowed to flow by gravity. Anhydrous ammonia, a nitrogen supplying fertilizer, is most commonly applied by liquid injection.

4. Application with irrigation water. Some producers who are able to irrigate their crops use their irrigation water to apply fertilizer. A special device is used to mix liquid fertilizer in proper amounts with the water being supplied to the crop. This method is commonly used by greenhouse operators in fertilizing their crops.
5. Foliar application. In some special cases, fertilizers are applied by spraying the crop leaves with special mixes. Usually this method is used for applying small amounts of the minor nutrients to specialty crops. Research has shown foliar application of most field crops to be of doubtful value.

H. How should the application of fertilizer and lime be timed?

The timing of fertilizer application is just as important as the method. For top profits, fertilizer nutrients should be available to the plants as needed, but should not be lost from the soil before they can be used. General guidelines for timing the application of nitrogen, phosphate, potash, and lime are given as follows.

1. Nitrogen. Most nitrogen fertilizers are very easily dissolved by water. Rain therefore can easily wash this nutrient from the soil. Nitrogen then must be applied just before planting or at the time planting takes place. As already mentioned in this lesson, many producers sidedress their crops with nitrogen after they have begun to grow. Only part of the total amount of nitrogen needed by the crop is put down at planting time. The rest is added later.

For forage crops, a similar practice called top-dressing is used. Nitrogen is applied by broadcasting at several times throughout the year. Small grains such
as wheat or oats, for instance, are planted and fertilized in the fall and then topdressed in the spring.

2. Phosphate. Unlike nitrogen, phosphate is not easily washed from the soil. A growing trend among some farmers is to broadcast phosphate in the fall using a spin spreader or truck. Some growers in fact are applying enough phosphate in one treatment to last for two or three years. This saves on application costs.

3. Potash. Potash is also held by soils having a medium to heavy texture. Sandy soils however do not hold this nutrient as well. On the clay and loam sands therefore potash can be broadcast in the fall while sandy soils should be fertilized with potash at planting time. (Note: If a complete fertilizer such as 13-13-13 is used, it should not be applied until planting time to avoid loss of nitrogen in the mixture.)

4. Lime. Most of the lime applied to crop land in Mississippi should be broadcast in the fall and thoroughly mixed into the soil. As already mentioned, lime does not take effect as soon as it is put down. It usually takes at least three months for the lime to begin to neutralize soil acid. Basic slag does go into solution faster than lime but it also is much more expensive to buy. If lime is not ground to the degree that it will pass through a 20 mesh screen, it may take three years or longer to become effective. (A 20 mesh
screen has 20 openings on each side of a square inch or
400 openings per square inch.)

I. How is the cost of fertilizer determined?

Fertilizer prices are determined in part by the
percentage of active nutrients found in the fertilizer. To
determine the true cost of fertilizer divide the selling
price by the percentage of active nutrients. This
percentage should be expressed in hundreths. A 30 percent
active ingredient equals .30, for example. If super-
phosphate costs $75.00 per ton and contains 20 percent or
.20 phosphate the true cost would be $75.00 divided by .20
or $375.00 per ton. Suppose triple superphosphate could be
purchased for $120.00 per ton. It contains 45 percent
phosphate. The true cost of the phosphate in this source
would be equal to $120.00 divided by .45 or $266.67 per
 ton. Triple superphosphate would then be the best buy.

J. Summing Up

Everyone recognizes the importance of supplying extra
nutrients to plants by using fertilizers. Usually three
major nutrients are applied to most crops. These nutrients
are nitrogen, phosphate, and potash. Other nutrients are
needed by plants, but usually they are already present in
the soil without having to be added. In some special
cases, boron, magnesium, zinc, sulfur, and molybdenum may
need to be added for specific crops.

Soil pH plays a major role in soil fertility. As pH
FIGURE 25B
Calculation Of True Cost: Of Fertilizer

<table>
<thead>
<tr>
<th>Material: Super phosphate</th>
<th>Material: Triple Super phosphate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage Active Ingredients: 20%</td>
<td>Percentage Active Ingredients: 45%</td>
</tr>
<tr>
<td>Cost: $75.00/ton</td>
<td>Cost: $120.00/ton</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Calculation</th>
<th>Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$375.00</td>
<td>266.67</td>
</tr>
<tr>
<td>$75.00</td>
<td>$120.00</td>
</tr>
<tr>
<td>60</td>
<td>90</td>
</tr>
<tr>
<td>150</td>
<td>300</td>
</tr>
<tr>
<td>140</td>
<td>270</td>
</tr>
<tr>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td>100</td>
<td>270</td>
</tr>
<tr>
<td>30.0</td>
<td>30</td>
</tr>
<tr>
<td>270</td>
<td></td>
</tr>
<tr>
<td>300</td>
<td></td>
</tr>
<tr>
<td>270</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>
decreases, nutrients in the soil become harder to get. Lime is the most common material used to raise pH.

All fertilizers must be tested for nutrients and the results of this test printed on the container. The grade of a fertilizer is printed in terms of the N-P-K ratio. A 5-10-15 ratio indicates that the fertilizer contains 5% nitrogen, 10% phosphate, and 15% potash.

Ammonium nitrate (33.5%N), urea (46%N), anhydrous ammonia (82%N), and nitrate of soda (16%N) are the most common sources of nitrogen. The most common sources of phosphate are superphosphate (18-20%P) and triple superphosphate (45-50%P). The most common source of potash is muriate of potash (60%K).

Soft calcitic lime is the main liming agent used in Mississippi though some farmers favor basic slag. Basic slag is much more expensive to purchase, but reacts more quickly with the soil and contains some phosphate and potash.

Fertilizers are commonly applied by broadcasting, banding, or liquid injection. If the crop is to be irrigated or is being grown in a greenhouse, the fertilizer may be mixed into the water.

The time when fertilizer is applied can be very important. Nitrogen should be applied immediately before planting or at the time of planting. A second application of nitrogen later in the growing season may be helpful.
On most soils, phosphate and potash can be put down in the fall or at planting time. If a complete fertilizer is used, it should be applied at planting time to avoid loss of nitrogen in the mix. Lime should be applied to cropland during the fall and completely mixed into the soil. Lime can take 3 to 6 months or longer to react in the soil.

When purchasing fertilizer a producer should consider the cost of the material and the percentage of active nutrients in the mix.
V. HOW MUCH HAVE YOU LEARNED?

A. Fill in the rest.

1. An _r__n_ fertilizer is a material which supplies nutrients to plants as the result of decay.

2. When a producer sprays fertilizer on the leaves of a plant, the _o_a_ application method is used.

3. On most soils _h_p_ and _o_t_ can be applies in the fall months and will still be in the soil the next spring.

4. _d_ is a process of placing a band of fertilizer near the plants of a growing crop.

5. When a fertilizer is labeled 6-8-10, it contains ___% potash, ___% nitrogen, and ___% phosphate.

6. As the pH of a soil increases, the amount of acid in the soil _e_r_s_.

7. Three common sources of nitrogen are: _N_t_, N_r_e of _o_d_, and _U_.

8. _b_ is a minor nutrient which is sometimes required by soybeans.

9. The relative ability of a soil to provide the nutrients needed by plants is referred to as _o_f_

10. Lime can take from ____ to ____ months or longer to react with the soil.
B. Check it off. Place a check (✓) by each wrong statement or answer. (Note: For statements 3, 6, and 7, one or more answers may be wrong.)

____ 1. Soils with low pH levels are called alkaline or "sweet" soils.

____ 2. The degree of fineness to which lime has been ground does not affect its ability to react in the soil.

3. Materials which raise the pH of a soil include:
   ___ a. basic slag
   ___ b. urea
   ___ c. superphosphate
   ___ d. soft calcitic lime

____ 4. Sidedressing is usually done to crops like cotton or corn.

____ 5. A soil with a pH of 5 is ten times more acid than a soil with a pH of 6.

6. Functions of nitrogen include:
   ___ a. causing rapid growth
   ___ b. increasing protein content
   ___ c. making stalks stiffer
   ___ d. reducing lodging
7. Minor plant nutrients include:
   ____ a. potassium
   ____ b. calcium
   ____ c. phosphorus
   ____ d. zinc

8. Many greenhouse managers use a mixture of water and nutrients to fertilize their plants.

9. Basic slag takes longer to react with the soil than lime does.

10. Ammonium nitrate is a nitrogen fertilizer which is usually injected into the soil using a special plow.

C. Figure it out. (Show all work in the space provided.)

1. What is the true cost of the phosphate in triple superphosphate if it costs $112.00 per ton and contains 50%P?
2. A fertilizer graded 13-13-13 would contain 13%N, 13%P, and 13%K. This means that 39% of the material in each bag is plant nutrients. If 13-13-13 costs $140.00 per ton, what is the true cost of the nutrients in the mixture?

3. A fertilizer graded 8-8-8 contains 8%N, 8%P, and 8%K. This equals 24% total nutrients. If it costs $95.00 per ton, what is its true cost in terms of total nutrients?
CROSSWORD PUZZLE

ACROSS

1. Applying fertilizer to the total soil surface.
4. A major nutrient which gives plants vigor and disease resistance and makes stems stiffer.
6. A basic element which provides raw materials for plant growth.
9. A material used to raise pH which also supplies phosphate and potash.
11. A major nutrient which gives plants a dark green color.
12. Nitrogen should be put down at ________ time.

DOWN

1. A minor nutrient needed by cotton.
2. A ________ fertilizer contains N, P, and K.
3. A scale used to measure acidity.
5. Applying fertilizer in a narrow strip near the seed.
7. The ________ of fertilization is as important as the method.
8. A pH of 7 is _________.
10. A soil with a pH of 6.0 would be _________.

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Situation: A wheat producer needs to purchase nitrogen fertilizer to topdress the winter wheat crop in spring. Ammonium nitrate, which contains 33.5% nitrogen, costs $133.00 per ton. Urea, which contains 46.0% nitrogen, costs $165.00 per ton. Nitrate of soda costs only $68.00 per ton and contains 16.0% nitrogen.

1. What is the true cost per ton of pure nitrogen for each source? (Show all work in the space below and on the back of this sheet. Write your answers in the blanks below.)

   Ammonium Nitrate _________________________
   Urea _________________________________
   Nitrate of Soda _________________________
Multiple Choice. Place a check by the best answer to each statement or question.

1. As the soil pH drops below 5.5, plant nutrients in the soil:
   ___ a. Are washed out
   ___ b. Become harder for plant roots to get
   ___ c. Become easier for plant roots to get
   ___ d. Are not affected

2. Important functions of nitrogen are:
   ___ a. Giving plants a green color and promoting rapid growth
   ___ b. Neutralizing acids in the soil
   ___ c. Making stalks stiffer and helping fight diseases
   ___ d. Reducing lodging and speeding up blooming

3. Fertilizers produced by man-made chemical processes or mining are called:
   ___ a. Organic Fertilizers
   ___ b. Muriates
   ___ c. Ureas
   ___ d. Inorganic Fertilizers

4. A fertilizer which contains nitrogen, phosphate, and potash is called:
   ___ a. A complete fertilizer
   ___ b. Basic slag
   ___ c. A secondary fertilizer
   ___ d. A total urea

5. A major function of potash is to:
   ___ a. Reduce soil acids
   ___ b. Give green color
   ___ c. Increase plant nutrient availability
   ___ d. Make stalks stiffer
6. Zinc, boron, and molybdenum are examples of:

   ____ a. Organic Fertilizers
   ____ b. Major Plant Nutrients
   ____ c. Minor Plant Nutrients
   ____ d. Chemical Fertilizers

7. A liming material which also supplies phosphate and potash is:

   ____ a. Basic Slag
   ____ b. Urea
   ____ c. Soft Calcitic Lime
   ____ d. Muriate

8. It usually takes at least how many months for lime to react within the soil?

   ____ a. 1
   ____ b. 3
   ____ c. 6
   ____ d. 12

9. A machine used to broadcast fertilizer is called a:

   ____ a. Injector
   ____ b. Bander
   ____ c. Sidedresser
   ____ d. Drop Type Spreader

10. The main function of lime is to:

    ____ a. Give plants a green color
    ____ b. Make stalks stiffer
    ____ c. Provide disease resistance
    ____ d. Reduce soil acid

True/False. Circle T if the statement is True. Circle F if it is false.

   T   F  1. A common source of nitrogen is urea.
   T   F  2. A fertilizer labeled 6-8-10 would contain 6% phosphate, 8% nitrogen, and 10% potash.
   T   F  3. Sidedressing is a process used to add fertilizer to crops that are already growing.
   T   F  4. Most crops in Mississippi grow best in a soil pH of 6.0 to 7.0.
T  F  5. The three major plant nutrients are nitrogen, phosphate, and calcium.
T  F  6. The basic chemicals and compounds which provide the raw materials for plant growth are called plant nutrients.
T  F  7. The main material used to lime soils in Mississippi is soft calcitic lime.
T  F  8. Nitrogen fertilizer should be applied at planting time.
T  F  9. Anhydrous ammonia is usually applied by broadcasting.
T  F 10. As pH of a soil decreases the amount of acid in the soil decreases.
INDEPENDENT STUDY
SURVEY QUESTIONNAIRE

This survey is being conducted in order to determine how students and teachers feel about some of the units of instruction produced by Mississippi State University. The three units are Unit 21, "Introduction to Rowcrop Production"; Unit 23, "Plant Selection"; and Unit 25, "Plant Nutrients and Fertilizers." You are asked to answer the questions and items on this survey form as honestly as you can. Your first thoughts are most important. This is not a test. There are no right or wrong answers. Do not sign your name. Read the instructions to each section carefully before answering the questions or items.

A. Personal Information. Place a check by the appropriate answer.

(13-14) 1. My age is ______ 13 _____ 14 _____ 15 _____ 16 _____ 17 _____ 18 or older

(16-17) 2. My grade in school is ______ 9th _____ 10th _____ 11th _____ 12th

(19-20) 3. When I leave high school, I plan to:

   _____ a. Work in an agricultural mechanics job (01)
   _____ b. Work in a forestry job (02)
   _____ c. Work in a greenhouse, nursery, or landscape business (03)
   _____ d. Work on a farm (04)
   _____ e. Work in an agricultural business (co-op, feed mill, etc.) (05)
   _____ f. Work in a conservation or recreation business or agency (06)
   _____ g. Work in an agricultural processing company (07)
   _____ h. Go to college and take agriculture (08)
   _____ i. Go to college and take some other subject (09)
   _____ j. Go to the military (10)
   _____ k. Work in a non-agricultural job (store clerk, secretary, factory worker, carpenter, etc.) (11)
   _____ l. Don't know (12)
   _____ m. Other. Please explain briefly ____________________________

   _____________________________________________________________ (13)

(22) 4. My overall grade average in all courses is:

   _____ a. 95-100 (8)
   _____ b. 90-94 (7)
   _____ c. 85-89 (6)
   _____ d. 80-84 (5)
   _____ e. 75-79 (4)
   _____ f. 70-74 (3)
   _____ g. 65-69 (2)
   _____ h. Below 65 (1)
DIRECTIONS FOR ANSWERING
ITEMS B AND C

Items B and C on the following pages are designed to evaluate your feelings about the teaching method and instructional content of the three units. Both Item B and Item C consist of nine pairs of words. The words in each pair have very different meanings. Between each pair there are seven blanks. These blanks represent a scale for rating how you feel about the topic being evaluated. You will find the topic being evaluated defined at the top of each page.

HERE IS HOW YOU ARE TO USE THIS SCALE:

If you feel that the topic is very closely related to one or the other end of the scale, you should place your check mark as follows:

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If you feel that the topic is quite closely related to one or the other end of the scale, you should place your check mark as follows:

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If the topic seems only slightly related to one side as opposed to the other side, then you should check mark as follows:

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</table>
If you feel that the topic is equally related to both words, or it is not related at all to either word, or if you cannot decide how the topic relates to the words; then you should place your check mark in the middle space:

very closely related  quite closely related  only slightly related  equally related  only slightly related  quite closely related  very closely related


IMPORTANT:  (1) Place your marks in the middle of spaces, not on the boundaries:
(2) Be sure you mark every scale for every concept—do not omit any.
(3) Never put more than one mark on a single scale.
(4) Your first impression is most important. Work rapidly but do not be careless.
B. Instructional Method. The words and scales below are designed to evaluate your feelings about the instructional method used to teach the units. Your class was taught using an independent study method. This method involves having you to read material, answer questions and learning activities, and then take a test. Please check how your feelings about this method relate to each pair of words.

**THE METHOD OF INSTRUCTION WAS:**

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C. Instructional Content. The words and scales below are designed to evaluate your feelings about the instructional content of the units you studied. Instructional content means the information which the units contained related to rowcrop production, plant selection, and the plant nutrients and fertilizers. Please check how your feelings about the information relate to each pair of words below.

THE INSTRUCTIONAL CONTENT OF THE UNITS WAS:

LEcTURE-DIscUSSION
SUrVeY quEStIoNNAIIRe

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DIRECTIONS FOR ANSWERING
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HERE IS HOW YOU ARE TO USE THIS SCALE:

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OR


If you feel that the topic is quite closely related to one or the other end of the scale, you should place your check mark as follows:


OR


If the topic seems only slightly related to one side as opposed to the other side, then you should check mark as follows:


OR

If you feel that the topic is equally related to both words, or it is not related at all to either word, or if you cannot decide how the topic relates to the words; then you should place your check mark in the middle space:

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GOOD  ____  ____  ____  X  ____  ____  ____  BAD

IMPORTANT:  (1) Place your marks in the middle of spaces, not on the boundaries:
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(4) Your first impression is most important. Work rapidly but do not be careless.
B. Instructional Method. The words and scales below are designed to evaluate your feelings about the instructional method used to teach the units. Your class was taught using a lecture-discussion method. This method involves having your teacher present the material in each lesson in a lecture or talk. You were supposed to listen and take notes. You were then tested on the information which was discussed. Please check how your feelings about this method relate to each pair of words.

THE METHOD OF INSTRUCTION WAS:

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C. Instructional Content. The words and scales below are designed to evaluate your feelings about the instructional content of the units you studied. Instructional content means the information which the units contained related to rowcrop production, plant selection, and the plant nutrients and fertilizers. Please check how your feelings about the information relate to each pair of words below.

THE INSTRUCTIONAL CONTENT OF THE UNITS WAS:

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</tr>
<tr>
<td>(42)</td>
<td>Unorganized:</td>
<td>__: __: __: __: __: __: __:</td>
<td>Organized</td>
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<td>(43)</td>
<td>Meaningful:</td>
<td>__: __: __: __: __: __: __:</td>
<td>Meaningless</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(44)</td>
<td>Boring:</td>
<td>__: __: __: __: __: __: __:</td>
<td>Interesting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank you for your help.
APPENDIX D

SCHOOL MEANS FOR ANTECEDENT AND DEPENDENT VARIABLES

BY TREATMENT GROUP
Table D-1

Number of Students and Class Mean on Antecedent Variables
by Individual School in the Independent Study Treatment Group

| School ID Number | Number of Students | \( \bar{x} \) Age | \( \bar{x} \) Grade | \( \bar{x} \) Reading Test | \( \bar{x} \) Pretest 1 | \( \bar{x} \) Pretest 2 | \( \bar{x} \) Pretest 3 |
|------------------|-------------------|-------------------|-------------------|--------------------------|----------------|----------------|----------------|----------------|
| 101              | 15                | 15.00             | 9.80              | 38.67                    | 50.00          | 46.33          | 41.00          |
| 102              | 26                | 15.22             | 9.70              | 39.77                    | 55.77          | 49.04          | 41.54          |
| 103              | 21                | 15.52             | 9.90              | 32.76                    | 52.38          | 47.38          | 47.86          |
| 104              | 25                | 15.00             | 9.08              | 40.28                    | 50.40          | 49.80          | 40.20          |
| 105              | 25                | 14.84             | 9.44              | 39.08                    | 46.60          | 47.00          | 42.60          |
| 106              | 22                | 14.50             | 9.00              | 30.82                    | 48.64          | 48.18          | 40.00          |
| 107              | 13                | 14.31             | 9.00              | 39.00                    | 59.23          | 52.69          | 42.69          |
| 108              | 14                | 14.50             | 9.00              | 25.71                    | 45.71          | 52.41          | 46.79          |
| 109              | 14                | 14.79             | 9.04              | 31.57                    | 48.21          | 47.14          | 45.00          |
Table D-2

Class Means on Dependent Variables by Individual School in the Independent Study Treatment Group

<table>
<thead>
<tr>
<th>School ID Number</th>
<th>$\bar{x}$ Posttest 1</th>
<th>$\bar{x}$ Time Unit 1</th>
<th>$\bar{x}$ Student Assignment 2</th>
<th>$\bar{x}$ Posttest 2</th>
<th>$\bar{x}$ Time Unit 2</th>
<th>$\bar{x}$ Student Assignment 3</th>
<th>$\bar{x}$ Posttest 3</th>
<th>$\bar{x}$ Time Unit 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>101</td>
<td>72.67</td>
<td>3.60</td>
<td>81.87</td>
<td>61.00</td>
<td>5.40</td>
<td>76.53</td>
<td>53.33</td>
<td>5.93</td>
</tr>
<tr>
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<td>3.11</td>
<td>76.92</td>
<td>68.08</td>
<td>4.84</td>
<td>82.81</td>
<td>65.58</td>
<td>6.35</td>
</tr>
<tr>
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<td>2.53</td>
<td>92.19</td>
<td>55.95</td>
<td>4.59</td>
<td>100.00</td>
<td>66.43</td>
<td>5.55</td>
</tr>
<tr>
<td>104</td>
<td>71.20</td>
<td>4.04</td>
<td>66.84</td>
<td>71.60</td>
<td>7.50</td>
<td>42.44</td>
<td>76.60</td>
<td>9.68</td>
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<td>72.60</td>
<td>4.16</td>
<td>82.12</td>
<td>68.40</td>
<td>4.56</td>
<td>76.44</td>
<td>61.00</td>
<td>4.20</td>
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<td>67.73</td>
<td>2.08</td>
<td>68.00</td>
<td>60.00</td>
<td>2.45</td>
<td>12.09</td>
<td>54.32</td>
<td>2.48</td>
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<td>79.23</td>
<td>2.76</td>
<td>83.46</td>
<td>93.08</td>
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<td>86.46</td>
<td>77.85</td>
<td>4.73</td>
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<td>81.50</td>
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<td>3.79</td>
<td>88.57</td>
<td>77.50</td>
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<td>72.79</td>
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<td>83.00</td>
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</table>
Table D-3

Number of Students and Class Means on Antecedent Variables
by Individual School in the Discussion Group

<table>
<thead>
<tr>
<th>School ID Number</th>
<th>Number of Students</th>
<th>( \bar{x} ) Age</th>
<th>( \bar{x} ) Grade</th>
<th>( \bar{x} ) Reading Test</th>
<th>( \bar{x} ) Pretest 1</th>
<th>( \bar{x} ) Pretest 2</th>
<th>( \bar{x} ) Pretest 3</th>
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<tbody>
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<td>25</td>
<td>14.40</td>
<td>9.00</td>
<td>36.48</td>
<td>55.20</td>
<td>46.40</td>
<td>50.80</td>
</tr>
<tr>
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<td>37</td>
<td>15.06</td>
<td>9.71</td>
<td>41.00</td>
<td>53.78</td>
<td>52.57</td>
<td>51.35</td>
</tr>
<tr>
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<td>9.12</td>
<td>43.69</td>
<td>50.56</td>
<td>50.33</td>
<td>53.61</td>
</tr>
<tr>
<td>215</td>
<td>27</td>
<td>15.89</td>
<td>10.08</td>
<td>35.74</td>
<td>50.00</td>
<td>45.56</td>
<td>46.15</td>
</tr>
<tr>
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<td>22</td>
<td>14.81</td>
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<td>35.06</td>
<td>45.00</td>
<td>42.05</td>
<td>41.67</td>
</tr>
<tr>
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<td>53.00</td>
<td>46.50</td>
<td>42.50</td>
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Table D-4

Class Means on Dependent Variables by Individual School in the Lecture-Discussion Treatment Group

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<th>School ID Number</th>
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<th>Time Unit 1</th>
<th>Student Assignment 2</th>
<th>Posttest 2</th>
<th>Time Unit 2</th>
<th>Student Assignment 3</th>
<th>Posttest 3</th>
<th>Time Unit 3</th>
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<tbody>
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<td>69.12</td>
<td>73.20</td>
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<td>68.12</td>
<td>64.00</td>
<td>15.00</td>
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<tr>
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<td>79.46</td>
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</table>
Table D-5

Number of Students and Class Mean on Antecedent Variables
by Individual School in the Control Group

<table>
<thead>
<tr>
<th>School ID Number</th>
<th>Number of Students</th>
<th>$\bar{x}$ Age</th>
<th>$\bar{x}$ Grade</th>
<th>$\bar{x}$ Reading Test</th>
<th>$\bar{x}$ Pretest 1</th>
<th>$\bar{x}$ Pretest 2</th>
<th>$\bar{x}$ Pretest 3</th>
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<td>57.86</td>
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<tr>
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<td>14.38</td>
<td>9.08</td>
<td>32.54</td>
<td>49.78</td>
<td>48.61</td>
<td>44.72</td>
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<tr>
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<td>15.50</td>
<td>10.25</td>
<td>43.33</td>
<td>59.58</td>
<td>56.67</td>
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<td>50.48</td>
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Table D-6
Class Means on Dependent Variables by Individual School in the Control Group

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<th>$\bar{x}$ Time Unit 1</th>
<th>$\bar{x}$ Student Assignment 2</th>
<th>$\bar{x}$ Posttest 2</th>
<th>$\bar{x}$ Time Unit 2</th>
<th>$\bar{x}$ Student Assignment 3</th>
<th>$\bar{x}$ Posttest 3</th>
<th>$\bar{x}$ Time Unit 3</th>
</tr>
</thead>
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<td>55.50</td>
<td>*</td>
<td>*</td>
<td>50.50</td>
<td>*</td>
</tr>
<tr>
<td>322</td>
<td>58.89</td>
<td>*</td>
<td>*</td>
<td>55.00</td>
<td>*</td>
<td>*</td>
<td>49.44</td>
<td>*</td>
</tr>
<tr>
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<td>58.33</td>
<td>*</td>
<td>*</td>
<td>54.58</td>
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<td>323</td>
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<td>49.76</td>
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<tr>
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<td>62.00</td>
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<td>60.75</td>
<td>*</td>
</tr>
</tbody>
</table>

*Values for time spent and scores on student assignments were not applicable to the control group.
VITA
VITA

James S. McCully, Jr., was born December 8, 1950, in Louisville, Mississippi. He was raised on a dairy farm in Winston County and attended Louisville High School. Upon graduation, he enrolled in the agricultural education program of Mississippi State University. He received the Bachelor of Science degree in 1972 and was employed as a vocational agriculture teacher at Lafayette County High School, Oxford, Mississippi in that year. In January, 1975, he resigned his teaching position to accept the duties of curriculum specialist for vocational agriculture programs with the Research and Curriculum Unit for Vocational-Technical Education of Mississippi State University. He received the Master of Science degree from this institution in December, 1975, with a major in Agricultural Education and a minor in Guidance.

Dr. McCully is a member and deacon in the Evergreen Baptist Church, Louisville, Mississippi. He is married to the former Pam Jones of McCondy, Mississippi. He is currently employed as curriculum coordinator and research and curriculum specialist with the Research and Curriculum Unit.

Dr. McCully is a member of the following organizations: MSU Alpha Zeta chapter, MSU Gamma Sigma Delta chapter, Mississippi Association of Vocational Agriculture Teachers, the National Vocational Agriculture Teachers Association, Mississippi Association of Vocational Educators, the American Vocational Association, and the LSU Alpha Tau Alpha chapter. His previous writing experience includes research reports, curriculum reference units/guides, and magazine articles.
Candidate: James S. McCully, Jr.

Major Field: Vocational Agricultural Education

Title of Thesis: Comparison of Independent Study to Group Study Methods in Mississippi Basic Vocational Agriculture Programs

Approved:

[Signatures]

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:

July 16, 1981