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**SYSTEMATIC APPROACH TO THE DEVELOPMENT OF AN
AGRICULTURAL ENGINEERING COURSE**

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SYSTEMATIC APPROACH TO THE DEVELOPMENT OF AN
AGRICULTURAL ENGINEERING COURSE

By

Glen Hayward Hetzel

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taking the course in an audio-tutorial format as well as those taught by traditional methods.

Laboratory exercises were assigned upon the student's performance on a module. The audio-tutorial scoring students were compared to the students with progress in the traditional lecture-laboratory format.

ABSTRACT

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influence on their achievement in the course.

Class size, student entry level experience, limited resources and physical facilities and instructor work loads all contribute to the need for developing alternatives to traditional lecture-laboratory methods of presenting instructional material.

A service course in farm machinery offered through the Agricultural Engineering Department at Michigan State University was developed into an audio-tutorial format. Traditional lectures were replaced with the audio-tutorial modules during the term. Supplementary laboratory exercises were developed to help students achieve the learning objectives for each module.

The achievement of similar students enrolled in the course a year earlier, when it was taught by the same instructor using traditional lectures and laboratory exercises, was compared to the students enrolled in the course as it was presented in the audio-tutorial format. Students

taking the course in an audio-tutorial format performed as well as those taught by traditional methods.

Laboratory sections were assigned according to each student's performance on a pretest for the course. High scoring students were placed in one section and students with progressively lower scores were placed in other sections. Comparisons of students within the class found that prior experience with farm machinery had no significant influence on their achieving the learning objectives for the course.

A large investment of time and other resources are necessary to totally develop a course into an audio-tutorial format. The reduction of time and resources to manage such a course for large numbers of students will probably justify the initial investments. High levels of student achievement should be maintained as compared to using the traditional lecture-lab format.

My special thanks are given to Mr. [Name] for his willingness to accept this exercise as an official activity of the department. His faith in the [Name] has added incentive to [Name]

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1.2 The Course

Agricultural Engineering

considered to be a survey course in agricultural engineering, covering the basic principles of design, construction, maintenance and utilization. The syllabus is designed to provide students with an understanding of the basic principles of agricultural engineering.

mechanical principles and the operation of typical agricultural machinery systems.

I. INTRODUCTION

This study was designed to use a systematic approach to develop an Agricultural Engineering course (A. E. 058, Farm Machinery) into a student-paced, individualized instruction format based upon the audio-tutorial concepts.

1.1 Major Concerns

The work to be presented here is concerned with the justification for using an audio-tutorial approach as an alternative to conventional lectures. It is also concerned with the need for understanding more about the learning process and how it influences the presentation of instructional material to a learner. Some of the characteristics of individualized instruction will be presented. Finally, various procedures will be given to help the reader gain some feeling for developing a student-paced, individualized course. The majority of students

lived on farms. Students in Agriculture have been encouraged to return to farming. Most are seeking adjustment of agricultural machinery systems. Students of machinery systems. Students of machinery systems. Students of machinery systems.

1.2 The Course

Agricultural Engineering 058, Farm Machinery, is considered to be a survey course on farm machinery management and utilization. The syllabus of the course is structured to provide students with an understanding of the basic

mechanical principles and the safe adjustment and operation of typical agricultural machines. Principles of farm machinery system management are included.

The traditional presentation format for A.E. 058 was to have two 1-hour lectures and one 2-hour laboratory period per week. During the second half of Winter Term 1975, the instructional material was presented using slide-tape modules in lieu of lectures. All laboratory periods and lab exercises were retained.

1.3 Student Characteristics

Students taking the Farm Machinery course are enrolled in the Institute of Agricultural Technology at Michigan State University. Most of the students are training in Agricultural Production or Power Equipment Technology. These programs are both eighteen months in length. Students enrolled in either program take courses Fall and Winter Terms and then go on work placement until the next Fall Term. At the end of the second Winter Term, the student receives his diploma. The majority of students enrolled in A.E. 058 have lived on farms. Students in Agricultural Production usually return to farming. Most are concerned with operation and adjustment of agricultural machinery, as well as management of machinery systems. Students in Power Equipment Technology usually seek employment in machinery dealerships. Their

primary concerns are with maintenance and repair of farm machinery, not management or operation of machinery systems.

Typical students enrolled in an agricultural technology program are not as strong academically as four year college students. High grade point averages are not a motivating factor with most of these students. The majority of technology students are more interested in practical, usable facts and techniques than in the theoretical aspects of the subject.

1.4 Need for Instructional Improvement

A questionnaire prepared by the author and completed by incoming students showed that these students have considerable variation in backgrounds and experience with farm machinery, farm machinery systems and the management of farm machinery. The traditional method of presentation resulted in loss of interest or motivation for those students having considerable experience with farm machinery. Because of the wide variation in the background knowledge and skills of those entering the course, and size of the class (approximately 100 students), it was necessary to consider a new approach to the presentation of the instructional material.

There is a sound basis for developing courses in which the instructional material is presented to learners by some other means than lectures. Paul Cameron, at Wayne State University, conducted studies that show only 12% of

those attending conventional lectures actually are paying attention to the speaker at any particular time (Postlethwait, 1969). It becomes necessary to create an environment where the learner is motivated to become involved in the educational process (Postlethwait, 1969).

at. Wor An evaluation of an audio-tutorial mastery learning program within the Institute of Agricultural Technology at Michigan State University was done by T. H. Cooper (1975). He concluded from the results of his study that the implementation of an audio-tutorial mastery learning program might result in better attitudes toward learning and increased achievement by the students. Because students enrolled in A.E. 058 were in the Institute of Agricultural Technology, and had similar backgrounds to those in Cooper's study, the use of an audio-tutorial approach to the presentation of the instructional material seemed feasible.

instructional system is at Cornell University
 1.5 Successful Programs in
 Rebbugler (1973) Individualized Instruction

in a Pa Samuel N. Postlethwait, Professor of Biology at Purdue University, has been involved since the early 1960s with a program to develop biology courses into student-paced units. The first unit was so successful he began work on others. Students in these biology courses listened to tapes while watching slides or 8 mm movies. They also stopped the tape to do laboratory type exercises with real specimens on tables that were located nearby.

At Michigan State University, Henry D. Foth has succeeded in using a similar system with a mastery concept in the Soils Department (Foth, 1967; Schaefer et al., 1969). Most of the information is presented by slide-tapes. Students are given experiments to perform or samples to look at. Work tables are set up in the learning center for the students' convenience.

At Central Nebraska Technical Institute, Hastings, Nebraska, the curriculum has been set up on the mastery system, using the student-paced approach. These are mostly vocationally oriented courses. A similar program is being developed at the Calhoun Area Vocational Center, Battle Creek, Michigan, by Paul Williams. His courses are in the area of Agricultural Power.

The only course that has been reported by an Agricultural Engineer as having been developed into a self-paced instructional system is at Cornell University. G. E. Rehkugler (1973) developed a series of slide-tapes for use in a Farm Power course in the Agricultural Engineering Department. All class material was presented by slide-tapes and handouts. Conventional laboratory sessions were held weekly.

(1974), professor of Electrical Engineering at Cornell University, states that engineering is not a matter of specialists and do not want to use the same methods. Many of them acquired their knowledge

II. REVIEW OF LITERATURE

Interest is continuing to grow in universities and other institutions of learning with regard to the feasibility of using alternative ways of presenting instructional material. Since the 1960s, college instructors have attempted to improve on the traditional lecture system of presenting learning materials to students. An awareness has developed that there are differences in students' background, their rate of learning, factors affecting learning and the results of learning. If an instructor is to successfully restructure a course and its method of presentation, he must take all of these into consideration.

2.1 Hindrances to Developing Alternate Teaching Methods

2.1.1 Limitations to course development

In a discussion of the reasons for using audio-tutorial methods of presenting a course, J. C. Lindenlaub (1974), professor of Electrical Engineering at Purdue University, states that engineering instructors are subject matter specialists and do not usually think about teaching methods. Many of them acquired their teaching skills

through experience. Most universities do little to motivate a professor to improve his teaching. Universities may have to provide rewards for improvements in teaching as they currently do for research, publications and obtaining grants (Perlburg et al., 1970).

An estimated 1200 to 1300 hours is required to develop typical courses into audio-tutorial courses (Ronzheimer, 1973). Instructors doing the development need to have their work load adjusted to allow adequate development time (Hoffer, 1973). A. A. Root (1974), Department of Instructional Technology, Syracuse University, suggests that a developer involve others in an effort to generate support for the new developments. A team effort is much preferred to working alone (Plants, 1974).

2.12 Role of the instructor

The role of the teacher has been seen as being principally a presenter of material, motivating students to learn and giving reinforcement when they did learn (Bugelski, 1971). The instructor's role with regard to an audio-tutorial course is mainly to design, implement and administer the automated systems used to present the material (Lindenlaub, 1970). The instructor may function more as a tutor than as a disseminator of knowledge in the future. He will probably have more opportunity to work singly with students needing help.

2.2 Learning

2.21 Learner differences

Few college teachers in the past concerned themselves with the individual differences between their students. Plato was aware of these differences and is quoted as having written ". . . for it comes to my mind when you say it, that we are not born all exactly alike, but different in nature, for all sorts of different jobs" (Virgis, 1966). Because no two students are exactly alike, we must design programs that are sensitive to their differences (Diamond, 1973).

Until recently, individual differences were recognized only to the extent that slower learners were either forced out of college or encouraged to drop out. Most college courses are still taught with a presentation form that is suited more to those who learn at a faster rate. Interest is growing in methods of presenting course material that allow the learner to more nearly match his rate of progression to his rate of learning. Techniques of presentation that allow the student to control his own rate of progress are known as self-paced methods of instruction. Variation in the rate of learning must be considered as alternate methods of course presentation are developed.

2.22 Learning

What is learning? A concise definition given by Davis et al. (1974) is that learning is a relatively

permanent change in someone's behavior resulting from experience or practice.

Gagne (1970) clarifies the definition by stating that such a change of behavior is not explained by the process of growth. Two basic kinds of learning are denoted by Gagne (Briggs, 1970). The first of these is reproductive learning which includes rote memorization of information, recall of information or the development of motor skills. Learning basic formulae and principles in engineering courses or the manipulation of controls of laboratory equipment fall under reproductive learning. The second kind of learning denoted by Gagne is productive learning. Using principles or concepts to solve problems is considered as a productive learning process and includes much of the learning activity of an engineering student in advanced courses.

2.23 Principles of learning and motivation

Students' attitudes toward a course are influenced by a number of factors. Davis et al. (1974) have identified nine general principles of learning and motivation that may have influence on students. As alternative methods of presentation are being developed, the instructor should attempt to utilize the following principles:

1. A student is likely to be motivated to learn things that are meaningful to him.
2. A student is more likely to learn something new if he has all the prerequisites.

3. The student is more likely to acquire new behavior if he is presented with a model performance to watch and imitate.
4. The student is more likely to learn if the presentation is structured so that the instructor's messages are open to the student's inspection.
5. A student is more likely to learn if his attention is attracted by relatively novel presentations.
6. The student is more likely to learn if he takes an active part in practice geared to reach an instructional objective.
7. A student is more likely to learn if his practice is scheduled in short periods distributed over time.
8. A student is more likely to learn if instructional prompts are withdrawn gradually.
9. A student is more likely to continue learning if instructional conditions are made pleasant.

A closer look at these principles of learning and motivation is warranted. The first principle is concerned with the meaningfulness of the material from the student's point of view. When course objectives are specified in the development phase, they must be selected for their meaningfulness to students as well as their relevancy to course goals. Students will be more receptive to information if they understand its use or importance with regard to their own needs.

The second principle supports the need for incoming students to have the necessary background skills and knowledge before attempting to learn new concepts or skills. Pretests can be used to determine what the student knows when entering a course. Remedial work is sometimes necessary

to ensure that students are adequately prepared before new instructional material is presented.

In engineering courses, example problems and examples of ways to solve various types of problems are commonly given. These are techniques used to model the kinds of behavior expected from students. Case studies are often used to develop a better understanding of more advanced kinds of problems and appropriate means of solving them. Support for following these practices is given by the third principle.

There is no room for ambiguity in a learning situation. The fourth principle points this out. Presentation of learning material should be clear and straightforward. Students should not have to guess what was meant or required to meet the objectives. It is imperative that learning material be presented as clearly and simply as possible.

Novel or unusual methods of presentation can be used and still not confuse students. The fifth principle supports using different approaches to presenting the instructional material. The use of different media often helps achieve some degree of novelty. A break with tradition may be necessary to achieve a degree of novelty.

One way of departing from conventional methods of presenting instructional material is given in the sixth principle. Students can be required to actively participate in the learning process by the inclusion of hands-on exercises during periods of instruction. Computers or

all other students.

laboratory equipment can often be utilized to involve the student actively in the instructional process.

Instruction: Traditional lecture presentations have inherent limitations that can be overcome when setting up a course for self-paced instruction. The seventh principle is more easily used in self-paced instruction because information can be introduced in small amounts and the length of the instructional period can be kept short if desired.

Development: As instructional material is developed for use in an audio-tutorial presentation, examples or hints can be used frequently when new ideas or concepts are introduced. As the presentation continues, less prompting would be used to guide the student to the desired behavior. Gradual withdrawal of prompts is indicated in the eighth principle.

Self-Paced: When a course is being developed into a self-paced, audio-tutorial one, attention should be given to the learning environment. The ninth principle of learning and motivation concerns the conditions under which instruction occurs. Attractiveness and comfort of the learning environment and the convenience of its use are all important and conducive to good performance by students.

Instruction: All nine principles of learning and motivation need to be followed when using a systems approach to developing or restructuring a course. While the content of engineering courses may be different than many other subject areas, the students involved in the learning process are similar to all other students.

2.3 Individualized Instruction

2.31 Defining individualized instruction

Most students wonder what kind of lecturer the instructor will be when they first think about a new course. This is natural as it has been a rare course that was offered using any other method of presenting the course material. Now, alternative methods of teaching are being developed and used. Many of these alternative methods involve some type of individualized instruction. Madeline Hunter (1970), principal of University Elementary School of UCLA, describes individualized instruction as a process that "custom tailors" instruction to fit a particular learner. This does not mean each student is taught differently, or the instructor prepares a different presentation for each student. What is implied is that the instructional presentation must be appropriate for each student receiving it.

2.32 Individualized instruction vs. conventional instruction

Perhaps the best way to explain what individualized instruction is would be to compare the primary differences between the traditional lecture method and an individualized instruction method. Table 1 compares the differences as discussed by Gagne and Briggs in their book, Principles of Instructional Design (Gagne et al., 1974).

Table 1.--Traditional vs. Individualized Instruction Methods.

	Traditional	Individualized Instruction
1. Instruction	By lecture	By alternative means (slides, tapes, etc.)
2. Presentation	To group	On individual basis
3. Scheduling	Set class time	Flexible time for viewing materials and length of time spent
4. Scope of Material	Limited depth and quantity covered	Depth and amount covered can vary with individual student
5. Instructor-Student Interaction	Time per student limited	Instructor can spend more time per student if needed

Traditionally, instructional material has been presented verbally during lecture periods. In an individualized instruction format, most of the instructional material is made available to the learner through methods and forms that allow him to work alone during the instructional period. This leaves the student free to select the time for receiving instruction. He also determines the length of time he will devote to receiving instruction at any one session. Such a system is called a self-paced system. Slower learners are able to devote more time and repeat as much material as is needed to meet the objectives.

Extra or optional material can be prepared and made available to fast learners or to those desiring greater depth. If only the required material is covered, a fast learner may attain all course objectives much sooner than a slow learner. A study done on computer-assisted instruction found the fastest student finishing in one-fifth the time required for the slowest student (Mitzel, 1970).

The instructor using an individualized instruction system usually has more time to spend working with students on a one to one basis because he does not lecture two or three times a week. That time can be spent helping those in need of extra explanation.

2.33 Added advantages to individualized instruction

As a course is being developed using a systems approach, thought should be given to making some special

provisions in its administration (Diamond et al., 1975). A variable time frame for learning has already been discussed. In addition to recognizing that all students do not learn at the same rate, and thus require more or less learning time, two other provisions are desirable. The first is to develop more than one version of the post-tests and make them available at various times for the convenience of students. If students are allowed to progress at their own pace, the testing program should be organized to allow testing at comparable rates. When low scoring students are allowed to retake a test, as in the mastery system, their level of achievement usually improves (Cooper, 1975).

The other desirable condition of administering a course is to provide for students a choice of locations where they can receive instruction. Many universities have learning centers in the main library and some learning centers within specific departments or colleges. When more than one location is utilized, students may find time to view or use instructional material for short periods when near a learning center. Crowding of a single facility may be eliminated.

2.34 Examples of individualized instruction

Individualized instruction is not just a single technique for developing and presenting instructional material. There are a number of different approaches that have been taken to provide a course in an individualized format.

In its simplest form, an independent study program by a single student would be an example. The instructor usually helps the student select the learning objectives and acts in an advisory capacity. The student is expected to find and use whatever supporting material is appropriate.

Computer aided instruction (CAI) is another example of individualized instruction. A computer is programmed in a manner that allows students to work alone with it to learn the assigned material. Usually, the program is flexible enough that most students will be able to complete the desired instructional sequence without necessarily following identical steps.

2.35 Personalized system of instruction

One of the better known forms of individualized instruction is the format developed by F. S. Keller and J. G. Sherman (Keller et al., 1974). It was originally known as a Personalized System of Instruction, but is commonly called the Keller Plan. The Keller Plan makes use of self-pacing as do most of the variations of individualized instruction. Lectures may be used, but only as a means of presenting supplementary material. The main method of presenting instructional material and allowing for student response is through the written word. Students with poor reading skills may be at a disadvantage in this method. Student proctors are used and often act as tutors to those having difficulties.

The most distinctive feature of the Keller Plan is that it is based upon the concept of mastery learning. The mastery learning concept implies that there has been some agreed upon level of performance for mastery learning and a means of determining if that level has been achieved. The skills and knowledge to be obtained by the learner when completing the instructional program have been identified beforehand (Anderson et al., 1975). The Keller Plan is probably best suited for elementary courses in a subject hierarchy because they usually present definite knowledge or basic information and skills (Dessler, 1971). If there is no adequate textbook for a course or if mastery of the material is not required, the Keller Plan should not be used.

2.36 Audio-tutorial system of instruction

Another type of individualized instruction that has been successful is known as audio-tutorial instruction. S. N. Postlethwait (1969), Professor of Biology at Purdue University, began using taped supplementary lectures in 1961. He gradually added various visual materials for the students to use. This apparently was the beginning of what is now known as the audio-tutorial system of individualized instruction.

2.37 Reasons for instructional system failures

New techniques do not always yield the same results for all users. Some methods may have a high level of success and other methods may be failures. Though many of the successful uses of individualized instruction have been reported, few of the failures are publicized. There is no way of knowing how many failures have resulted or how many successful courses exist.

J. G. Sherman (1972), one of the originators of the Keller Plan, feels that most failures result from problems that are related to the three following categories.

1. Problems inherent in the system used. These might include such factors as the quality of the equipment and facilities used, choice of location, times available or testing procedures.
2. Problems created by modifying the basic pattern of the individualized system of instruction used. Examples would be requiring students to attend lectures in a system intended to be self-paced or giving tests at mandatory times.
3. Problems that are created because of the differences between the world of the instruction and the "outside world." These usually are related to the lack of transferability of the instructional material to the real world.

Developers attempting to set up a course on an individualized instruction basis for the first time should not vary appreciably from tried and proven methods. As the development process continues and feedback supports the need for changes, modifications can be considered.

2.4 The Audio-Tutorial System of Instruction

2.4.1 Features of audio-tutorial systems

Audio-tutorial systems of instruction rely on an audio-tape as a primary means of presenting learning material. It is an individualized system of instruction in the sense that students listen to the tapes alone and have direct control of their rate of progress (self-paced) through the instructional materials (Lindenlaub, 1974). The student usually has freedom to choose the time he will use the instructional materials. Audio-tutorial instruction is an ideal method for use in engineering courses that require learning a manipulative skill (Lindenlaub, 1970) because examples can easily be given and the student can stop the tape while practicing skills. The learner can review the slide-tape to check if the correct procedure is being followed.

There are a number of other features that make audio-tutorial instructional systems attractive for use in engineering education (Johnson et al., 1970). One of these is the fact that the developer has considerable freedom to

choose the kind of media to be used. Video tape, 35mm slides, 8mm movies and printed material have all been used successfully. Another feature is that audio-tutorial courses are self-contained and can be easily stored or transported to locations remote from campus. A feature that keeps the audio-tutorial system on a human level (as compared to computer aided instruction in particular) is that an instructor can be present to help students if the need arises.

2.42 Reasons why engineers like audio-tutorial systems

Engineers seem to like the idea of using audio-tutorial instruction (Lindenlaub, 1974). This may be because the primary instructional mode is still verbal (like lectures) and such a system is fairly simple to start. Preparation of an audio-tutorial system of instruction is not radically different from preparing lectures. Students using the audio-tapes seem to be at ease listening to them, especially if the instructor has made the tapes.

2.43 Summary of the audio-tutorial system

Because the work being presented in this dissertation is based upon the audio-tutorial system of individualized instruction, a summary of the system may be helpful. Such a summary is given by S. N. Postlethwait et al. (1969).

1. The emphasis is on learning by the student, not on teaching.

2. The student controls the pace of advancement through the course.
3. Progressive students are able to choose their path of progress.
4. The student chooses the time for using the course material.
5. The student is able to concentrate on the taped presentations.
6. The instructor is able to give each student more individual attention.
7. Scheduling of the course is usually simplified.
8. Such a system can usually handle more students in less space or fewer facilities than conventionally taught courses.
9. Makeup labs or review sessions are easily handled.
10. Students become aware of their responsibility toward learning.
11. Senior staff members are able to tutor each student as needed.
12. The "packaged" audio-tutorial courses are easily used at locations other than the home university.
13. Audio-tutorial systems of instruction are ideal for research on learning processes.

It can be inferred from the previous discussion that the primary difference between the traditional methods of instruction and those based on individualized instruction is not how learning occurs, but how the learning environment is set up and controlled (Gagne et al., 1974). Audio-tutorial systems of individualized instruction are designed to place the learner in surroundings that provide privacy and allow him to work at his own speed. Instructional materials that are included let the learner progress toward a particular goal and provide feedback to him.

2.44 Modules of instruction in audio-tutorial systems

Discussions of individualized instruction and particularly of audio-tutorial systems of instruction include references to modules of learning. A module is

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considered to be the unit of an individualized instruction system that corresponds to the "lesson" in conventional forms of instruction (Gagne et al., 1974). A module is a self-instructional package. It contains a statement of objectives and a fixed sequence of the instructional materials and often uses a variety of media (Russell, 1974). Provisions are commonly made for giving reinforcement to the learner for correct responses. Evaluation procedures are usually developed for a module and include pretests and post-tests. Ideally, a module could be used alone without regard to sequence with other modules unless there is prerequisite knowledge required.

One of the most important rules to follow when developing individualized instructional material is that the materials must be self-instructional (Bolvin, 1968). The learner must be able to use the module and the supporting equipment by himself to accomplish the stated objectives. Study guides outline the procedure to be followed. Activities the learner is expected to perform should be given in the study guide. The statement of the objectives may be part of the study guide (Green, 1972).

2.45 Preparation time

Everyone who has developed a course into some form of individualized instruction found that a considerable amount of time is required to get the materials into a usable state. If an audio-tutorial system is used, there

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is no easy way to estimate the time required to obtain the needed slides. In some cases suitable slides can be purchased, but developers often must take the pictures that are needed. Sorting and sequencing slides is very time consuming. Beginners will find it helpful to use the storyboard technique (Kemp, 1963) to generate the slide-narration combination.

The general feeling about the maximum length of viewing time per slide-tape is to keep it under sixty minutes (Ratledge, 1970). The rule of thumb on length of time to record the tapes is that recording times are two to three times longer than the final length of the tape.

2.46 Expected results

Studies have been conducted to determine the effectiveness of self-paced instruction in engineering courses (Hoferock et al., 1972). The results have shown self-paced instruction to be extremely effective for engineering education. Those courses with well defined objectives had better results than those with poorly defined objectives. Self-paced courses are more effective than lecture type courses according to Farmer et al., 1972, because students tend to have higher retention of course material after one term. More students score higher on final examinations and earn higher grades.

Billy V. Koen (1970), a professor in the Department of Mechanical Engineering at the University of Texas (Austin),

found students rated individualized instruction courses very favorably. The majority of the students felt such a course required more effort than conventionally taught courses, but looked forward to the next activity in the course. More than half of the students liked it better than lecture courses.

2.5 Development of an Audio-Tutorial Course

2.5.1 Starting

When an instructor considers developing a self-paced course, he is faced with the uncertainty of where to start. Helen Plants (1970), Professor of Mechanical Engineering and Mechanics and Professor of Curriculum and Instruction at West Virginia University, advocates the simple procedure of reading and thinking about starting, to get some idea of what needs to be done, then do it. Later, check the literature to find out what others have done and compare results. A caution is extended by Lindenlaub (1974). He advocates thinking big, but start small in an area about which the developer feels knowledgeable.

Three questions need to be asked by the developer with regard to his intended effort (Gagne et al., 1974). These are:

1. Where am I going? This is determined by writing the behavioral objectives. Specification of instructional materials.

objectives requires the developer to commit himself to a definite end result.

2. How will I get there? The learning materials must be acquired or generated and the method of instruction must be chosen to answer this.

3. How will I know when I have arrived? In order to know when the destination (the objectives) has been reached, it will be necessary to use some type of evaluation program. This commonly is done with post-tests.

The presentation method chosen will be governed by the nature of the course content, sequence of presentation required, activities required of the student and constraints imposed upon the system. Only after each of these factors has been considered can the course developer choose the hardware for presenting instructional material. Some instructional material can be best presented by lecture methods while other material can be presented to learners by a slide-tape format (audio-tutorial) or other means. Generation of instructional materials must be done in a manner that is compatible with the presentation method selected.

Several kinds of evaluation procedures are usually used. Entrance level abilities need to be determined to provide a basis for evaluating progress as students use the instructional materials. Pretests are commonly used to evaluate students at the beginning of instructional periods.

After the period of instruction has ended, post-tests are then given to determine if learners have attained the objectives.

2.52 Developmental problems

Course developers should try to avoid the following five types of problems due to shortcomings in the planning and administration of courses (Davis et al., 1974):

1. Problems of direction normally result from failure to make course goals or objectives known to students. Students should be given course goals and objectives for each module as the course progresses.
2. Problems of evaluation result when students do not
 1. know or understand the procedures used for evaluating them. Evaluation and grading systems should be explained at the beginning of the course.
 2. Problems with content or sequence result if content material is missing or the sequence is not logical. Care must be exercised to ensure that all learning material is included and properly sequenced for the learner's use.
4. Problems of method are commonly caused by poor conditions for motivating or promoting learning. Special attention should be given to the learning environment and to developing good motivation in learners.

5. Problems with constraints may be caused by failure to utilize students' abilities, skills of the instructor or other resources. Identifying students' abilities and those of the instructor allows incorporation of them into the course planning.

2.53 Functions of instruction

Many characteristics of conventional teaching and learning processes are true for individualized instruction also. Gagne and Briggs (1974) discuss functions that are served by events of instruction during a lesson. Most of the functions are as important when applied to modules in self-paced courses. These functions are:

1. Gaining the learner's attention.
2. Informing the learner of the objectives for the modules.
3. Stimulating the learner to recall prerequisite learnings.
4. Presenting the stimulus material (new content).
5. Providing learning guidance or practice exercises.
6. Eliciting the desired performance as a response.
7. Providing feedback to the learner with regard to his correctness.
8. Evaluating the learner's performance.
9. Improving retention and transfer of new knowledge.

Gaining the learner's attention is not a problem when using an audio-tutorial format. The learner's attention is usually tuned to the subject when he elects to view the slide-tape at a particular time. He can be given the statement of the objectives as he enters the learning center along with any other handout materials to supplement the slide tape. Both handout material and review statements on the audio-tapes can be used to help the student recall

previously learned information. The new instructional material is presented via the slide-tapes and through the use of handouts or laboratory exercises. The learner is subsequently guided through the instructional materials and simultaneously given an opportunity to practice the needed skills.

The student becomes involved in performing the required learning exercises and receives feedback about the accuracy of his performance from the instructional materials or from an instructor. Tests given after completion of each module are used to evaluate the student's performance. All of the functions that are characteristics of conventional teaching-learning processes are met when audio-tutorial methods are used.

2.54 Phases of course development

Almost everyone who has successfully developed and implemented an audio-tutorial course has worked in a systematic manner to achieve that success. There have been many different approaches to the developmental process. The literature contains many examples of ways that instructor-developers have organized their development. The reader is referred to Johnson and Johnson (1970) or Gagne and Briggs (1974) for examples of fairly detailed approaches to development of courses or modules.

Development of courses occurs in various phases.

Davis et al. (1974) designated the following three phases:

1. The analysis phase is concerned with describing the learner's current system or state, writing objectives or completely analyzing and describing tasks.
2. The design phase involves plan evaluation and design of some of the instruction system.
3. The evaluation phase includes the implementation of the instructional design and testing and usually leads to revisions.

Other writers (Mager et al., 1967; Briggs, 1970; Gagne et al., 1974) also recognize development as a three stage process. Sometimes, slightly different terminology is used but the activities are similar. There have been some developers who chose to break the three phases into more specific designations (Diamond et al., 1975; Tosti et al., 1969; Burgwardt, 1974; Russell, 1974).

2.55 Writing and using objectives

Regardless of the number of distinct phases or steps denoted by a developer, the one critical task is to specify the objectives of the course and the objectives of each module or instructional unit. In recent years, considerable stress has been placed on the development and use of objectives by instructors of college courses. Even though those in Colleges of Education have long been aware of the value and advantages of using objectives, engineering instructors have been slow to use them.

Learning objectives are descriptions of what the learner is expected to be able to do after instruction is completed (Davis et al., 1974). It should be kept in mind that instructional objectives describe an intended outcome of some type of learning activity and they should be expressed in behavioral terms (Mager, 1962). The typical objective has three parts (Mager, 1962; Davis et al., 1974). The first of these is known as the terminal behavior which tells what the student must do to show he has actually learned what is expected. The second part states the conditions under which the learned behavior must be exhibited and defines what is given or not given or the limitations under which the student must perform. The third part can be considered the standards of performance and tells how well the student must be able to accomplish the learned behavior. Typical ways of specifying standards include stating the lower limits of performance that are acceptable (Mager, 1962). These include giving time limits, minimum number of correct responses or the percentage or proportion of correct answers acceptable.

An example of an instructional objective follows:
At the end of the instruction period the learner will be able to work any three of the five practice problems on calculating field efficiency and obtain all the correct answers as given by the instructor, without using any references. The terminal behavior is: to work any three of the five practice problems on calculating field efficiency.

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The conditions for doing this are: at the end of the instructional period, without using any references. The standards to be met are: obtain all the correct answers as given by the instructor.

Educational objectives can become very complicated to write and use. There are three domains of such objectives (Johnson et al., 1970). They are:

1. Psychomotor domain (muscle control).
2. Affective domain (feelings and attitudes).
3. Cognitive domain (intellectual).

The cognitive domain is of most concern for the engineering instructor. It includes processes of remembering, understanding, and problem solving. Kinds of learning that involve mentally storing, retrieving or processing information are all in the cognitive domain.

Perhaps one of the best arguments for using behavioral objectives is given by Briggs (1970). He gives four reasons for writing them. They are:

1. To tell learners (and others) what the course should accomplish.
2. To help course developers know where they are trying to go.
3. To allow the instructor to provide students with a "study guide" for their learning experience.
4. To serve as an aid to instructors when reviewing daily progress (or the student's progress).

The preparation of course objectives is not just a matter of writing a number of objectives. The course developer who is attempting to follow a systems approach to set up an audio-tutorial course must learn how to select appropriate objectives for the course. He must also learn

how to organize the objectives from general information and skills to specifics (Briggs, 1970).

2.56 Task analysis

A systems approach to course development demands that the next step after specifying the objectives is to determine the sequence of the learner's tasks (Johnson et al., 1970). This is essentially task analysis, the act of breaking down a learning task into components that must each be mastered before the total task can be accomplished. Once the behavioral objective has been stated, a task analysis should follow to help ensure that all critical or pertinent learning tasks are included. An example of a task analysis is given for the task of planting corn.

Task: To plant a field of corn

1. Determine size of field
2. Select variety of seed
3. Select size and shape of seed
4. Determine field fertility level
5. Determine what mix of fertilizer to add
6. Determine what amount of fertilizer to add
7. Determine plant population per acre
8. Obtain fertilizer
9. Obtain seed
10. Prepare seedbed
11. Calibrate planter
12. Calibrate fertilizer applicator
13. Plant corn

2.57 Selection of materials and presentation form

Task analysis provides information needed to guide selection and/or generation of content material for the course. The previous example illustrates the many steps or

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tasks that a learner must be able to accomplish in order to achieve the task of planting corn. Instruction must be provided for all subtasks learners cannot accomplish initially. Course material is then selected to aid the learner in meeting the objectives. Before material is generated for a course, the developer should attempt to determine if any existing material is suitable for adoption or adaptation. The cost of using existing materials is often less (in terms of both money and time) than of generating new materials.

After the completion of the task analysis and the selection of the course material, the developer must select the instructional procedure to be followed (Mager et al., 1967). This phase of the development process includes the identification of the type of learning performances desired and then selecting those that are most practical. Mager et al. (1967) suggest the following guides to determining the sequence of the instructional materials:

1. Move from the general to the specific, from the "How to" to the "Why."
2. Present something of interest to the learner first.
3. Present what must be used in its order of use.
4. Teach the student enough to allow him to do a limited amount before training for mastery.
5. Present those skills, etc., used the most first.
6. Plan for practicing the total job at the end of the instructional time.

The final major decision of a developer following the systems approach is the selection of media to present course materials. If existing materials are utilized, he may not have any choice of media to be used for their

presentation. However, adapted or newly generated materials usually allow the developer to select the media for their presentation. As to be expected, the closer to real life the learning situation can be, the more predictable the results. However, there are many reasons why other alternatives must be accepted. Russell (1974) uses Dale's Cone of Experience as a model for the following media preference hierarchy. It starts from the real or concrete and progresses to the abstract.

Concrete

Level:

1. Real Life Experience
2. Physical Involvement with Artificial or Simulated Experience
3. Direct Perception of Experience
4. Indirect Perception of Experience
5. Visual Representation of Experience
6. Audio-Representation of Experience
7. Reading Verbal Description of Experience
8. Hearing Verbal Description of Experience

Abstract

Tosti and Ball (1969) feel that the student does not learn from the media but from the presentation form. Instructional modes that involve self-instruction, such as audio-tutorial presentations, are believed to be very efficient (Gagne, 1970) because they encourage the learner to develop habits of independent study.

2.58 Evaluation

Another area of concern when following the systems approach is with evaluation. The material presented and the students as they enter, progress through the course and leave, should constantly be evaluated. Contrary to popular belief, a true evaluation program is not just testing student performance. A comprehensive plan of evaluation will yield information about three aspects of the developer's concerns (Davis et al., 1974). These are: (1) the level of achievement of students entering the learning system; (2) the level of achievement of students leaving the learning system; and (3) the level of efficiency and effectiveness of instructional methods used in the learning system.

Another way of considering the desirability of an evaluation program is that a good evaluation program will supply answers to the question: "Who learns What under Which Conditions and in How Much Time?" (Russell, 1974). To be able to determine how much or what a student has learned, the instructor must know where the student actually started when he began the course. Very few faculty are actually aware of what or how much the entering student knows about their courses (Diamond et al., 1975). It is desirable to give pretests to determine how much the incoming student already knows about the course content (Bolvin, 1968). Provisions for a student to "test out" of a course should be considered. If he scores high enough on a pretest, he

should be allowed either to receive credit for the course or to select another course in place of that particular one.

Russell (1974) feels that the success of a newly developed module or component of a self-taught course is tied to the amount of effort the developer exerts in trying out the material and getting feedback from students. He will become aware of his limitations as a developer and will be able to make immediate revisions when needed. Constant monitoring of students during initial stages is necessary to evaluate new material for most effective use.

Two types of evaluation are of concern. These are formative evaluation and summative evaluation (Gagne et al., 1974). Formative evaluation is concerned with collecting evidence on the feasibility and effectiveness of the material and usually results in revisions and improvements. Summative evaluation is concerned with the effectiveness of a course after it has been developed. An ongoing type of evaluation is necessary to determine if the objectives of the course are being met.

McKeachie (1968) points out some of the problems that are associated with efforts to evaluate a teaching method. These include such things as the Hawthorne Effect, problems involved in obtaining suitable control groups and interactions among the variables being used. Most engineering instructors are not likely to be aware of the Hawthorne effect by name. When a group is monitored or tested experimentally, with their knowledge, they may perform differently

than if they did not know they were being monitored or tested. The resulting change of performance is known as the Hawthorne effect.

2.59 Testing

The remaining area for discussion is testing. Testing may be considered an area or mode of evaluation. A common misconception about testing is that it is necessary only for the purpose of assigning grades or determining how much a student knows. In addition to evaluating student performance, Briggs (1970) suggests that testing is a necessary step in the early stages of tryouts and revisions of new material. Testing must be included in a systems approach to developing a self-taught course. Results from such tests should be used as feedback to support making revisions.

As a teacher generates a test he must consider the expected result of instruction (Ebel, 1970). In audio-tutorial courses the outcomes of instruction are specified by the course objectives. Criterion tests, the post-tests, are constructed only from the objectives (Mager et al., 1967). The object of testing is not to make it a game to determine if teachers can outguess students with tricky questions.

Examinations should be scheduled at fixed times. Students should be informed about the questions to be asked and acceptable answers. Post-tests are based on the objectives for each module. Students should be aware of the main

concepts or principles of the course. When students know they will be tested at a particular time on certain material, they should perform better (Ebel, 1970). Many teachers recognized that taking a test should be a learning experience for students. One educational psychologist, James B. Stroud (Ebel, 1970) suggests that time spent in taking a good test may be as valuable a learning experience as anything else students may do.

Davis et al. (1974) give four properties that must be met when designing good test items: (1) validity, which can be defined as the requirement that the behavior to fulfill a test item must be performed under the same conditions as are specified in the learning objectives; (2) reliability, which refers to the requirement that a test item provide a consistent measure of the learner's ability to demonstrate achievement of an objective; (3) objectivity, which results when a number of people versed in that subject agree that the learner's performance does meet the criteria stated in the learning objective; (4) differentiability, when a test item is constructed in such a manner that only learners who have achieved the objective can do what is required.

It becomes apparent that a well constructed test requires considerable time and effort to develop. Such tests can be utilized more than once. Robert Ebel (1965), professor in the Department of Counseling, Personnel Services and Educational Psychology at Michigan State University, suggests that first it be used as a closed book test

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and then as an open book test. While this may not be very suitable in an audio-tutorial course, it could be used as a pretest for other students.

There are two other concerns when developing tests. These are the efficiency of a test and its practicability (Briggs, 1970). One way of obtaining efficiency is to design tests as short as possible with many items. Objective type tests usually have high efficiency. The practicability of a test is usually a function of such factors as the time and effort required to give and grade it as well as consideration of the space or facilities needed.

There are ways of testing for reliability and difficulty of a test item (Herum, 1970). Many universities now offer machine grading of tests with computer programs to perform item analysis. Such things as item difficulty, reliability and index of discrimination are calculated to help test developers analyze the results of their efforts to construct fair tests. The reader is referred to Herum (1970) for the methods of calculating the index of discrimination and the item difficulty by hand.

When developing a test, the instructor has a choice of the form of the questions. Russell (1974) lists these seven forms of test questions: (1) multiple choice; (2) matching; (3) completion; (4) short answer; (5) true/false; (6) actual performance items; and (7) essay. Scores from these tests can be converted to grades by using: (1) numerical scaling; (2) pass-no pass; (3) the number of

objectives achieved; or (4) the level of the objectives achieved (Davis et al., 1974). Regardless of the form of the questions, they should be graded as quickly as possible with results made known to the learner to increase his rate of learning (Herum, 1970). Quick return usually helps keep the interest level up.

The history of education shows that conventional methods of teaching result in a flow of information from instructor to student. Students send back information to the instructor only in response to questions or on tests. Self-taught courses have changed this somewhat. The instructor acts more as a resource person and guides the student in his study. Interaction between the student and the instructor is usually increased in audio-tutorial courses.

III. PROCEDURES

This section is concerned with the procedures used to plan, develop, and implement an audio-tutorial course in farm machinery. The course, Agricultural Engineering 058, Farm Machinery, was offered during the winter term of 1975 at Michigan State University for students enrolled in the Institute of Agricultural Technology. It is a required course in the curriculum of those students in the Power Equipment Technology option and the Production Agriculture option. These students receive four terms of on campus instruction and six months work placement training for experience.

3.1 Reasons for Developing the Course

3.11 Original course

Agricultural Engineering 058, Farm Machinery, has been offered for a number of years as a three credit course. It was offered as two 1-hour lectures and one 2-hour laboratory period per week. All students enrolled were expected to attend the lectures and labs. Each lab section was taught identically during any term. No effort had been made to determine what level of experience each of the

students possessed at the beginning of the course. They were all treated the same and were expected to perform the same. Until the winter term, 1975, the Power Equipment Technology (PET) students were enrolled in other farm machinery courses. The normal enrollment for A.E. 058 had been in the range of 75 to 80 students.

Starting Winter Term, 1975, A.E. 058 was added as a required course for those in Power Equipment Technology. This raised the expected enrollment to approximately 100 students.

3.12 Inherent problems

Students who had enrolled in the course during winter, 1974, were interviewed to determine what they disliked about the course. There were five inherent problems in the course and each had a bearing on what was necessary to make the course acceptable to the majority of the students. These problem areas thus became the focus of the efforts to modify the course for future offerings. The five problem areas of major concern are:

1. Students enrolled in the course came from widely varying backgrounds and life styles. There were students who had lived on farms all their lives and students who had lived in urban areas all their lives.
2. There was considerable variation in the amount of on-farm experience among the students. Some

students lived and worked on farms larger than 1,000 acres and owned various types and sizes of equipment. Other students had never seen or operated any farm equipment.

3. The expectations of those enrolled in the course varied. Some expected to learn how to overhaul complicated equipment. Others wanted to be able to identify the various kinds of machines.
4. Students enrolled in programs in the Institute of Agricultural Technology are not traditionally motivated to work for high grades. They are not as academically inclined as four year degree students but look for practical, usable information in their courses.
5. The inclusion of those majoring in Power Equipment Technology would add a group of students with expectations and motivations different from those of students in the Agricultural Production area. Those in Agricultural Production Technology are primarily concerned with operation and management of farm equipment. Those in Power Equipment Technology are concerned with set-up and repair of machinery.

If a revised form of the Farm Machinery course is to be accepted by future students, it must alleviate the problems imposed by its previous format and presentation

form. It was to this goal that the undertaking of the course revision and development was directed.

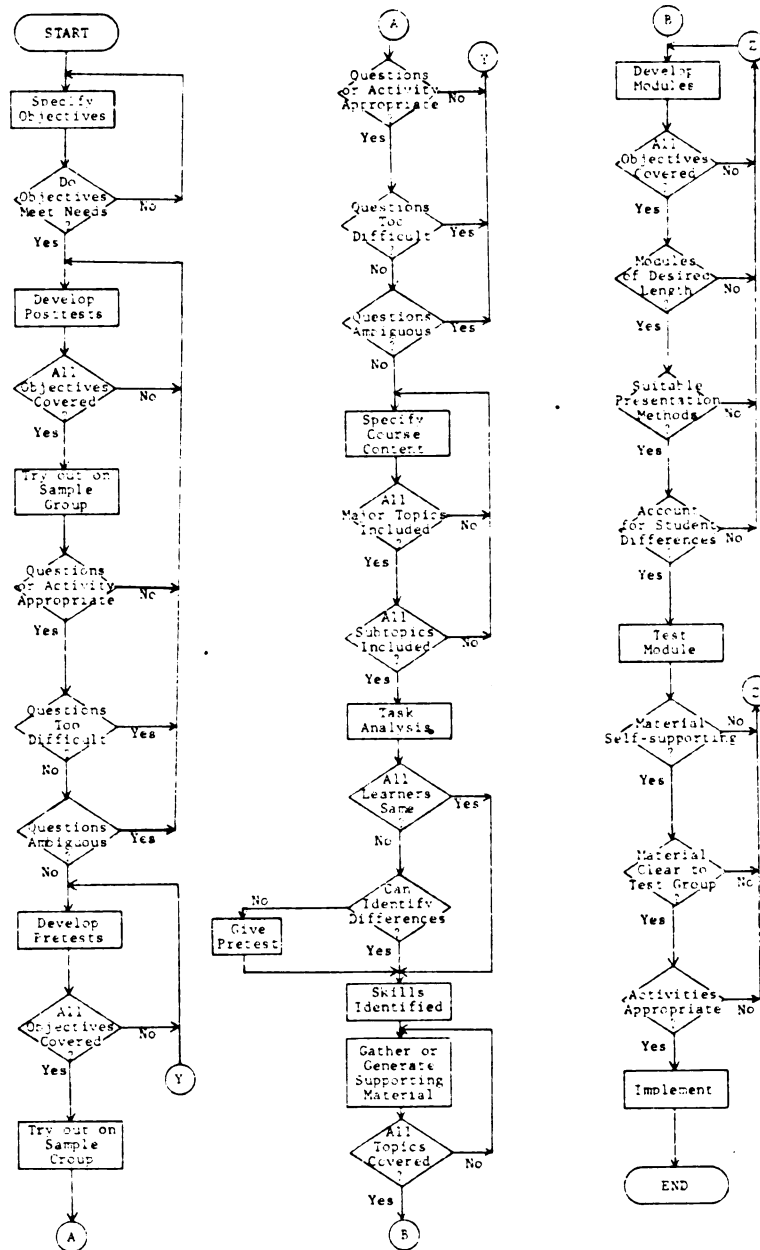
3.13 New approach

Consideration of alternative forms of course presentation was inhibited by the surprisingly few reported instances of individualized instruction in engineering courses. There are a few courses being developed in Engineering Departments at various universities. The decision was made to completely restructure the Farm Machinery course. It also necessitated the development of new instructional materials, which would be in the form of individualized self-paced instruction. The decision to make such a complete change in the method of presenting the course and to develop new materials was enhanced by the potential use of the material. Students enrolled in machinery design courses, other machinery courses and some foreign students could use the finished modules to supplement their course material or as a review before beginning advanced courses.

3.2 Phases of Development

The general development procedure followed is shown in Table 2, which is a flow chart of the basic steps or phases involved. As the final course had a number of modules, it must be pointed out that all modules were not in the same stage of development at the same time.

Table 2.--Course Development Flow Chart.



3.21 Syllabus revision

A systematic approach was utilized throughout development of the course. The starting point was a revision of the existing syllabus. This necessitated a series of meetings involving faculty concerned with the Technology programs and who were current on the changes and developments within the farm machinery area. These faculty were asked to identify what students needed to learn in a farm machinery survey course. They were also asked to recommend additional subject areas and to suggest which topics should be deleted from the course. Finally, a syllabus was formulated that seemed to meet everyone's approval. A section on how power is transmitted through machines (Power Trains) was added, as well as one on hydraulics. Appendix A contains the final working syllabus.

3.22 Module selection and sequencing

After the syllabus had been revised, the number of modules needed to present the instructional material was determined. These modules were formed by grouping the subject matter into related or similar topics. Fifteen modules were required to present the instructional material in a logical, topical manner. These are listed in Table 3. The modules were divided into two groups. The first group, modules 1 through 6, was concerned with information that pertained to all kinds of machinery or machinery systems and their management. The second group, modules 7 through 15,

Table 3.--Modules of Instruction for Farm Machinery Course.

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1. Machine System Management
 2. Equipment Sizing and Selection
 3. Power Drive Trains
 4. Power Take-Off Systems
 5. Tractor and Machine Hydraulics
 6. Hitches and Hitching
 7. Primary Tillage Equipment
 8. Secondary Tillage Equipment
 9. Planting Machines
 10. Chemical Applicators for Liquids
 11. Chemical Applicators for Solids
 12. Silage Making Equipment
 13. Hay Making Equipment
 14. Combine Harvesters
 15. Corn Picking Equipment
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was concerned with presenting instructional material about the various kinds of agricultural machinery.

Development of the total course could not be completed in the six months that remained before the course was scheduled to be offered again, so the course was divided into two halves. The first half contained general information and management information; the second half specific categories of machines. Initially, none of the topics in the first half would be restructured but would be presented by the conventional lecture format. Because of time constraints, six of the nine remaining topics on the syllabus would be developed into individual modules for use in the course. The other three modules would be developed for future use followed by those in the first half of the course.

Table 4 shows the separation of the modules according to the development time table. Modules are listed according to order of completion. This is based on the premise that if any delays occur in the development schedule, those modules for use last in the course would be completed first. Such a sequence for developing a course eliminates the likelihood of students being introduced to a new method of instruction and then having to revert back to the original method before the end of the quarter.

Table 4.--Modules to be Developed for a Farm Machinery Course.

Phase I. To be developed for use during winter term, 1975

1. Combine Harvesters
2. Silage Making Equipment
3. Chemical Sprayers
4. Planting Machines
5. Secondary Tillage Equipment
6. Primary Tillage Equipment
- *7. Hay Making Equipment
- *8. Corn Picking Machinery
- *9. Chemical Applicators for Solid Chemicals

Phase II. To be developed for future use

1. Hitches and Hitching
 2. Tractor and Machine Hydraulics
 3. Power-Take-Off Systems
 4. Power Drive Trains
 5. Sizing and Selecting Agricultural Equipment
 6. Machine System Management
-

*To be developed as time allows.

3.23 Specification of objectives

The third phase in the development process involved specifying behavioral objectives for each module. What the learner was expected to do at the end of the instruction period (terminal behavior), the circumstances under which he would be able to accomplish the desired behavior (conditions) and the guidelines to be used to judge his level of accomplishment (criteria) were carefully stated. Each objective was checked for clarity. The objectives for the six completed modules are contained in Appendix B.

3.24 Development of post-tests

The fourth phase of the development process was to generate the quizzes (post-tests) that would be given when a student completed each module of instruction. Post-tests were designed to cover instructional material presented in the module and were based on the objectives for that module. Development and implementation of the modules required continuing evaluation. Each student was expected to take the post-tests for the six completed modules. This resulted in a total of almost 600 post-tests to be graded with the results returned to students in as short a time as possible. At least twenty questions were generated for each post-test. Only one version of a post-test was available for each module. Consequently, multiple choice, true false, matching or problem solving questions were used. All post-tests were hand graded immediately and test results were discussed with

the student. Later, all answer sheets were machine scored and a complete item analysis was run on each post-test. All post-tests are shown in Appendix C.

3.25 Development of pretests

After the post-tests were developed, generation of a series of pretests followed. These tests would serve to give some indication of what students knew about the subject beforehand. Each question on the pretests was based on one of the objectives from the modules. Many of the pretest questions were based on specific post-test questions also. This was done to allow checking particular items in an effort to determine how much learning took place through use of the instructional material and related learning experiences. All pretest questions were the objective type with up to five responses for each question. These were machine scored. Two pretests were generated. The first contained questions about material to be covered in the first three modules. The second included material to be covered in the last three modules.

As each pretest was developed it was administered to a student on a trial basis. The particular student selected had been allowed credit for the course after he scored high on the placement test during the fall orientation. He was available to assist with further development of the course. His comments and suggestions were used as a

basis for clarifying test items before the pretests were used in Winter Term, 1975.

Each pretest was tested a second time before being administered to the whole class. This was done by allowing five students enrolled in the class to take the pretests and then review them with the instructor after grading.

The five students were chosen as a result of their performance on the first hour test in the course. Two had scored the highest, two the lowest and one was near the median for the class. The highest and lowest scorers were used in an effort to determine clarity of wording and to check for bias of test items. Their comments and criticisms were obtained through an interview with the instructor after the quizzes had been graded. Suggestions and criticisms from these students were used as a basis for making final corrections or clarifications before the whole class was allowed to take the pretests. The final version of each pretest are contained in Appendix D.

The same students and procedure were used to try out each of the post-tests before it was given to the entire class. This procedure was followed in an effort to eliminate as many problems with poorly worded questions as possible.

3.26 Development of instructional material

As the pretests and post-tests were completed, the main task became that of developing the instructional

system. The method of presentation selected was to use slide-tape sets and allow students to view these whenever it suited them. Faculty members in the Agricultural Engineering Department involved in the Agricultural Technology program and the guidance committee members were consulted about the level of difficulty of the subject matter.

Slide-tapes were chosen because they could be used for audio-tutorial instruction and because the slides could be used to illustrate the details and relationships of machine components. The taped narrations could be utilized to give detailed explanation and presentations of the subject matter and could be easily replayed if the student felt he had missed a point being stressed.

The objectives for each module were used as the basis for developing each slide-tape set. A rough draft of the narration was written to provide the information to be learned. Then, slides were obtained to illustrate each important point. All commercial sources were checked in an effort to obtain suitable slides. Machinery manufacturers, educational supply companies and faculty members were all sources of suitable slides. Whenever appropriate slides were not found, it was necessary to make slides for use.

Considerable time was involved in cooperating with the machinery supervisor and machinery operators on the Michigan State University farms to set up particular machines or machine operations. The local weather became a critical factor in scheduling machine operations for picture taking.

Early frost ended a harvest season before suitable pictures could be obtained of all operations involved in making hay. Untimely rains caused delays in getting pictures of other operations. Some machines had to be set up in the machinery laboratory and partially disassembled to facilitate taking detailed pictures of machine components and their relationship to other parts.

As a general rule, three pictures were taken for each one used in the final slide set. This allowed selection of the one that showed the desired view or detail. Occasionally, slides were used that will be replaced when more suitable ones can be taken. Attention to a particular detail in a slide was highlighted by using a large white arrow (about 3 inches wide and 18 inches long) held pointing to the part being shown. All pictures were preplanned. This helped to reduce the actual time spent taking pictures. Except where a machine had to be partially disassembled, less than five minutes was spent per picture during the actual shooting.

Finished slide sets contained from 27 to 68 slides per module. After the final set of slides had been selected, five duplicate sets were made by a commercial source. The duplicate sets were used in the carrels. Each set was numbered and placed in carousel trays for the term. This allowed one complete set of slide-tapes per carrel and eliminated waiting for a slide-tape set by someone in another carrel.

After a slide set was finished, the final narration was written. This was done by using the rough draft as a basis and the finished set of slides. Typically, about eight hours of work was required to rewrite the rough draft and record the final taped narration. This included recording an audible signal to indicate when the slide should be changed. Audible signals were used instead of automatic slide changing to allow students to control the advancing of slides. This procedure involved the student more and allowed him to control his rate of progress. Students then had the option to stop the tape before advancing to the next slide if they were taking notes.

A maximum time of 30 minutes was selected as the limit for any audio tape. This allowed a student to view a tape in a 50 minute free period between other classes. There was enough time to take notes while viewing a slide-tape and still complete it in 50 to 60 minutes, as most of the tapes were around 22 minutes long.

Most modules had supplemental materials which were handed out at the time the slide tape was reviewed. These usually were sample problems or further elaboration of material presented on the tapes. Occasionally, corrections of taped material had to be given students as a handout. Appendix E contains samples of some of the supplemental material.

The textbook Farm Machinery Management by Donnell Hunt was used as a required reading reference. Reading

assignments were given at the beginning of the term. Some problems in the textbook were also assigned as homework to improve students' problem solving skills. A number of other publications were suggested as supplementary references and are listed in Appendix A.

3.27 Instructional material trial

All new instructional material must be tested prior to being used with large numbers of students. A trial procedure was formulated for this material. The developer of this course taught a portion of another farm machinery course, AE 443, the Fall Term of 1974. Many of the objectives for AE 058 were appropriate for that course. Those objectives which were appropriate were given to the students in AE 443 as guides for them. Pretest questions based on the appropriate objectives were given before the start of the machinery section of AE 443. Some questions were revised afterward in an attempt to remove ambiguities in terminology.

All instructional material in AE 443 was presented by lecture. A final exam was given at the end of the term. Many questions used on the final exam were taken from the post-tests that had been generated for use with the modules for AE 058. It was necessary afterwards to state some questions in a more specific manner. None of the instructional material was tested with the AE 443 class, except for some of the 35mm slides, as development was not complete.

Student reactions were used as feedback. A number of the original slides did not show enough detail and students could not identify or differentiate between components of specific machines. Some slides were replaced before being incorporated into the slide tape sets.

3.28 Selection of hardware and instructional system

The first half of this course was taught by lectures and laboratory exercises. The second half had been planned to be presented by slide tapes at the students' convenience. A university assigned lecture room large enough to hold the 98 students was available for the lectures. An office adjoining the Farm Machinery laboratory was made into an audio visual learning center and contained the learning carrels. The Director of the Instructional Resources Center (IRC) in the College of Education advised on brands of reliable equipment. Through the cooperation of the Dean of Resident Instruction's office in the College of Agriculture, five carrels designed for the use of slide projectors were obtained. Five Wollensak 2505 cassette tape player decks with head phones and five Kodak Ektagraphic slide projectors with remote cables were acquired in the same manner.

The room with five completely equipped carrels was open Monday through Friday from 8:00 a.m. to 5:00 p.m. or slightly later. The technician assigned to the Farm Machinery Laboratory checked the carrels and equipment. Students were on an honor system to use the equipment and

learning materials properly. All students were given demonstrations on the use of the equipment at the time the first slide-tapes were placed in service. They were requested to notify the lab technician in the Farm Machinery Lab or the course instructor if an equipment failure occurred. No equipment or slide-tapes were lost or damaged during the term.

Estimates about the number of carrels needed were based on the assumption that students would view each slide tape once. If one tape were introduced each week, each carrel would then handle twenty students during a forty-five hour week. The actual situation was that many students viewed each tape at least twice. These students tended to view the slide-tape the first time without stopping. The second time they would stop and take notes as they identified important points. Some students even reviewed the slide-tapes a third time immediately before taking the post-tests. Since a log was not kept of the actual usage, a conservative estimate is that each carrel was used at least forty times per week.

Each carrel was supplied with a set of slides and a tape for each of the six modules. A module introduced into the learning center was left there for the remainder of the term. Students used the room on a first come basis. Cueing for a turn was minimal and only occurred when a number of students had a free hour immediately before or after another class in the Agricultural Engineering Building.

Spot checks of the learning center rarely found it unoccupied. A normal rate of usage seemed to be about three carrels in use at any particular time.

3.29 Weekly laboratory periods

Each student was scheduled for a two hour laboratory period weekly. There were five laboratory sections per week. Students in a section had been pre-selected according to their score on a placement test that had been given in August, 1974. Students that scored in the highest quarter were in one lab section, those in the second highest quarter in another section, and so on. All of the students majoring in the Power Equipment Technology program were in a separate section. This was done to allow some variation in the presentation of each laboratory. Even though all labs for any week covered the same material, the level of difficulty was varied according to the background and previous experience of students in each lab. Previous to this, all labs were presented at the same level of difficulty and students with considerable experience often lost interest during the term.

Laboratory periods were utilized so students would have an opportunity for hands on learning experiences. Labs for all sections were on the same topic, but the level of the exercise varied according to the abilities of the groups. For example; students in the most advanced section would devote their lab time to developing skills on making

adjustments on the machines being studied that week while students who had scored lower on the placement test would devote their lab time to learning machine nomenclature and the general principles of its operation. The same equipment was used by all students for their laboratory work during any one week. Student interest was maintained at a high level because the difficulty of each lab was aimed at that particular group. The weekly schedule for all laboratory periods is shown in Appendix A.

3.3 Implementation

3.31 Placement testing

In August, 1974, most students enrolled in Agricultural Technology or Power Equipment Technology were on the Michigan State University Campus for an orientation program. While on campus, they were given a series of standardized tests. Included in these tests were math and arithmetic tests, a reading test, a chemistry test and others. Additional tests included one on farm power and a short twenty question quiz was on farm machinery.

Scores from this quiz were used as a basis for assigning each student to a particular laboratory section in the Farm Machinery course for winter term 1975. This test was not used as a pretest but served only as a basis for assigning students to specific lab sections.

3.32 Pretesting

A commonly used technique for determining what students have learned during any particular course is to use a pretest/post-test sequence. This is done by testing students before they start the instructional process in a course and then retesting them with similar questions at the end of the instructional period. When both sets of questions are based upon the learning objectives for a course, students' progress and the success of instructional materials can be determined.

Pretests for AE 058 were given in two parts. Material to be covered by the first three modules was included in the first pretest. This pretest was given at the beginning of each lab period during the fourth week of the term. Pretest questions from modules four, five, and six were combined into the second pretest which was given at the beginning of a class period during the fifth week of class.

A comprehensive pretest was finally developed by combining the original two pretests from the modules. In its final form, there were 108 questions about farm machinery. Incoming students for AE 058, Winter Term 1976, were given the combined form of the pretest in August 1975 (see Appendix D).

Students in the future should be assigned to various laboratory sections according to their scores on the actual pretest for the course. This would group students according

to their prior knowledge and experience. Each lab section could then be planned and carried out at a level of difficulty matched to the students.

3.33 Presentation of course material

Conventional lecture presentations were used for the first half of the course. Weekly laboratory periods supplemented the lecture material. Each student was required to hand in a lab report at the beginning of the lab period the following week. Most of the information needed to complete the lab reports was collected during the two-hour laboratory periods. Sample laboratory exercises are provided in Appendix F. All of the laboratory sections were taught by the instructor who gave the lectures. This helped give a certain amount of continuity in what was presented during the laboratory periods.

A one-hour examination was given during the fourth week of classes. It covered all course material that had been presented during lectures. Following that, all lecture periods were used for individual study. Students used the learning center in the Agricultural Engineering Building to view the slide-tapes on their own time. A few lecture periods during the remainder of the term were used to show films, give post-tests, or as question and answer periods. The instructor was always available to students during the time that class was normally scheduled to meet.

3.34 Post-testing

The last half of the course was developed using individualized instructional modules. The pretest/post-test procedure was only used for the last half of the course. Post-tests were not made available for students to take until one day after the introduction of a new slide-tape module. This time delay was included to discourage students from rushing through a slide-tape the first day and then taking the post-test without reading any of the reference material.

At least 75 percent of the instructional material in the second half of the course was presented by slide-tapes. However, some important information was intentionally left to be learned from the textbook. This use of two sources of instructional material meant that a student could pass a post-test without reading the reference, but could not usually answer enough questions to receive a high score on post-tests. Since the mastery concept was not being followed in this course, one version of each post-test was developed and students could take it only once (see Appendix C).

The instructor was involved with the five two-hour labs per week during the second half of the course. The rest of his time was devoted to the administration of the course. The procedure used to administer post-tests was quite simple but required a considerable amount of the instructor's time. Any time the instructor was in his office, students could request the post-test for the module

they were completing. Each post-test was in an individual folder with one machine gradeable answer sheet. Students were given the requested post-test and then went to a desk or table in an adjoining room to take the test. When the post-test was completed, it was returned to the instructor for immediate hand grading. After incorrect responses had been marked, the student was allowed to review his test and discuss it with the instructor. This became another learning experience for the student with an opportunity for discussion about missed questions. After the student had completed his review, the test and answer sheet were returned to the instructor so the grade could be recorded. All answer sheets for each post-test were eventually machine graded and item analysis was run. Students could complete a number of modules and then take more than one post-test at a time.

3.35 Final examination

A final examination was given for a number of reasons. Primarily, many students were apprehensive about taking a course which had the instructional material presented in an audio-tutorial manner. A comprehensive final exam was given to allow students an opportunity to review all course material and to enhance their chances of learning from the post-tests. The final examination accounted for about one fourth the total grade.

The final examination given was almost identical to the final examination given the year before when the whole course had been taught by the lecture-lab format. The only difference between the two examinations was the substitution of two problems that were based on actual practices rather than theoretical situations. Machine graded answer sheets were used for the entire examination which mainly consisted of multiple choice or true-false questions.

Students took the final examination as one group during the regularly scheduled period in finals week, Winter Term 1975. The answer sheets were machine scored and item analysis was run. Any student with questions about his performance on the final could review it with the instructor.

3.4 Evaluation

The evaluation process was aimed at two different goals: (1) determination of students' grades; and (2) evaluation of the effectiveness of the instructional materials and presentation system.

3.41 Grade determination

The total grade for a student was determined by totaling the number of points scored on the hour test, each of the post-tests, the final examination and all of the laboratory exercises. The breakdown of the total score is shown in Table 5. Grades were assigned using the general recommendations of Michigan State University as a guide.

Table 5.--Breakdown of Total Grade Into Component Parts by Percentages.

Component	Approximate Percentage (%)
Hour Test	17
Post-tests	20
Final	26
Laboratory Grades	37
Total	100

3.42 Instructional material effectiveness

Students were monitored informally to determine their initial reactions and criticisms about instructional materials and the presentation system. This was done by oral questioning after their post-tests or during conversations in the laboratory periods.

At the end of the term, students were asked to write their opinions and feelings on the SIRS (Student Instructional Rating System) form. All 98 of the students filled out the front side of the form that actually rated the instructor and the course. Only 87 students took the time to write comments on the back. Their comments will be discussed in the next chapter.

An additional follow-up questionnaire was prepared and mailed to 25 students from the 1974 Farm Machinery class and to 25 students in the 1975 Farm Machinery class. The

students were chosen by random selection from the class rolls. Questionnaires were identical for the two groups except an additional section was added for the 1975 class. The extra section was used to solicit their feelings about the use of the slide-tape modules in the course.

IV. RESULTS AND DISCUSSION

The previous discussion has included the procedure followed in developing the slide-tapes and supporting materials used in AE 058 during Winter Term 1975. Before presenting the results for discussion, I feel it necessary to define the student populations more clearly. Knowing some of the background of students, their attitudes about various aspects of farm machinery management and utilization and previous on-farm experience is helpful when preparing course material for presentation and when interpreting the data.

4.1 Student Characteristics

4.11 Student history profile

As a means of gaining more information about the students in the 1975 class, a Profile Survey Form and a Survey of Attitudes Form were used. The Profile Survey Form consisted of 22 questions designed to provide a brief personal history about each student. The summary of the responses is provided in Appendix G. The questions can be grouped according to similar topics and are shown in Table 6.

Table 6.--Profile Survey Questions by Similar Topics.

Topics	Questions
Students living on farms: size and kind	1-5
Student's experience with equipment	6-10
Source of equipment used on farm	11-15
Storage and repair of equipment	16-18
Vocational agricultural experience	19
Tractor information	20-22

4.12 Generalizations about profile data

The responses show that about 90 percent of the students have lived on a farm with 81 percent still living there. Sixty percent have lived on farms for 15 or more years. About one-third of the farms are dairy and one-fourth general farming. Almost half the farms are between 200 and 600 acres. Sixty percent of the students had taken some vocational agriculture in high school. Forty-eight percent had taken at least two years of vocational agriculture. Ninety-seven percent of all the students have operated tractors, but only 40 percent have operated a combine. The majority of students have operated the common tillage, planting and forage equipment. Only about 50 percent of the students perform one-half or more of the repairs to the machinery used.

All the information is useful when attempting to organize the course material, as more or less emphasis can be placed on the areas of greatest concern. The questions dealing with management will provide information for guiding future development of the first part of the course.

The first two problem areas discussed in the section on inherent problems of the course (lack of common base level of entering knowledge and nonuniform experience with agricultural machinery) are supported by the data shown in the Profile Survey Form. Students having greatly varying backgrounds cannot be expected to respond identically in a course since the degree of difficulty will not be the same for each student. Some effort must be made to present the course material at different levels of difficulty to meet the needs of all students. The data from the Profile Survey sheet helps to identify the depths of instruction that may be needed.

4.13 Student attitudes

The second form used to gain information about incoming students was the Survey of Attitudes Form. It is shown in Appendix H. The questions asked are grouped into three areas of concern about farm machinery. Table 7 shows the three topical areas covered and the appropriate questions in each area. The responses to questions 1, 5, 6, 7, 9, 10 and 14 are related to students' attitudes about aspects of machinery management. Material about machinery

Table 7.--Attitude Assessment Questions by Areas of Concern.

Area of Concern	Questions
Machinery Management	1, 5, 6, 7, 9, 10, 14
Machinery Adjustment	2, 8, 11
Safety	3, 4, 12, 13

management is presented in the first half of the course. Knowledge about students' attitudes toward some aspects of machinery management helps to pinpoint concepts needing more emphasis in the course. Examples are the following: while 69 percent of the students recognize that leasing equipment may be a good alternative to buying some farm machines, only 63 percent think hiring work done on a custom basis is desirable.

Questions 2, 8, and 11 provide information about students' attitudes on maintenance and adjustment of farm machinery. Eighty-nine percent of the students recognize that calibration of fertilizer application equipment is necessary before it is used. As 99 percent of the students already knew the advantages of following a good preventive maintenance program, little course time was needed to be devoted to it.

The third area covered by the Attitude Survey Form concerned some aspects of safety. Only 51 percent of the students felt there was merit in using rollover protection devices on farm tractors and 79 percent thought guards

should be required on moving parts that are exposed. Thirty-two percent of the students did not think the government should regulate use of agricultural chemicals. Each of these areas was included in the syllabus for additional emphasis.

4.2 Comparison of 1974 Class with 1975 Class

4.21 Kinds of tests used

As mentioned earlier most students enrolled in AE 058 had been given a series of standardized tests during their orientation program. Three of these tests and one additional test given at the same time were selected for use as a means of comparing students enrolled in the farm machinery course during 1974 and 1975. These tests were chosen because they are closely related to the Farm Machinery course (AE 058). Two of these tests were mathematical types (Arithmetic and Algebra) and one a mechanical aptitude test (DAT Mach). The fourth test was on farm power.

4.22 Results on tests

The results of these tests are shown in Table 8. Student's t-test was used to check the means of the two class groups for each test in an effort to determine if there was any significant difference between the two groups when they entered the course. The t-test was used to test the null hypothesis that there was no significant difference between the means for each class, $H_0: u_1 = u_2$. The

Table 8.--Data from Standardized Tests.

	Math	Arithmetic	DAT Mech	Farm Power
Possible Total	30	40	68	100

1974				
$\bar{X}$	8.875	28.72	55.62	48.31
Range	1-24	12-38	23-64	20-71
Mean	8.88	28.72	56.33	48.31

1975				
$\bar{X}$	8.754	27.88	55.64	50.07
Range	2-24	12-39	33-66	18-75
Mean	8.75	27.88	54.94	50.07

t_o	.1269	.665	1.09	1.09

Degrees Freedom	115	103	114	119

$t_{.05}$	1.9617	1.9857	1.974	1.98

Rejected H_0	No	No	No	No

two alternative hypotheses are: (1) the 1974 group is better than the 1975 group, or (2) the 1974 group is not as good as the 1975 group. That is: $H_1: u_1 > u_2$, or $H_2: u_1 < u_2$. The results from the t-tests as shown in Table 8 are that, in each case, the null hypothesis cannot be rejected at the 0.05 level.

On the basis of the students' performance on each test for both years, I conclude that there is no significant difference between the entry level of the two groups.

4.3 Performance of 1975 Class

4.31 Performance on final examination

A number of tests were given during the term to determine the progress of students as they completed various modules. As neither the modules nor the post-tests existed in 1974, no comparison can be made between the groups utilizing these results. But the final examinations given at the end of the term each year were basically the same. The only differences were some changes in format of a few questions to allow machine grading and a problem replaced in 1975 to increase its relevance to the course material.

Final examination scores of the students in each class were compared to determine if one class did significantly better. Only the fifty-one questions which were identical on the final exams were included when computing the raw scores for making the comparison. This was done to

eliminate any bias that might have occurred from one form of the questions being different than the other form.

The null hypothesis used to make the test was that there was no significant difference between the performance of the two classes on the final examination. Because there were unequal numbers of students in each class (71 in 1974 and 97 in 1975), the percent of each class getting the question correct was used. Then a paired t-test was made. The null hypothesis tested was $H_0: u_1 = u_2$ and the two alternative hypotheses are that the 1974 class performed better than the 1975 class, or the 1974 class did not perform as well as the 1975 class: $H_1: u_1 > u_2$, or $H_2: u_1 < u_2$.

4.32 Results of the t-test

The results of the t-test gave a t-value of 1.784 with 50 degrees of freedom. The t-value at the 0.05 level is 2.011. Since the calculated t-value is within the range of the table, the null hypothesis cannot be rejected. This indicates that those who used slide-tapes performed as well on the final examination as those receiving instructional material by lecture.

4.33 Course grade distribution

Further analysis was desirable to determine if one class performed better in the course. In order to make a test to determine this, the percent of students in each class obtaining the various grades was calculated. The

distribution of grades for each class is presented in Table 10.

Table 10.--Course Grade Distribution.

Grade	1974 (% of Total)	1975 (% of Total)
4.0	21.3	19.80
3.5	14.6	15.80
3.0	18.6	14.85
2.5	17.3	20.79
2.0	18.6	20.79
1.5	1.3	3.96
1.0	4.0	
0	4.0	3.96
Mean GPA	2.697	2.785*

*Significantly different from the 1974 class at the 5% level using student's t-test.

The paired t-test was run to check the null hypothesis that there was no significant difference in performance between the two classes. That is $H_0: u_1 = u_2$. The two alternative hypotheses tested were that the 1974 class had better grades than the 1975 class: $H_1: u_1 > u_2$, or the 1974 class did not have better grades than the 1975 class: $H_2: u_1 < u_2$.

The mean grade point average for the 1974 class was 2.697 and for the 1975 class was 2.785. The mean for the

1975 class was significantly higher at the 0.05 level which means the null hypothesis must be rejected. The calculated t-value of 4.83 compared to the table value of 2.145 indicates an increase in the performance of the 1975 class over the 1974 class. Most of the increase was in the number of 2.5 and 2.0 grades.

4.34 Evidence of learning

Other measures of student achievement were tested. In 1975, the students were given pretests on the material that was presented in each module and then were given post-tests after completing the modules. As the pretests and post-tests were developed, questions from the pretest were paired with questions on the post-tests. The percent of correct answers was tabulated for making the comparisons. Paired t-tests were made to determine if there was any significant difference in the performance on the pretests and post-tests. The same null hypothesis was tested in each case. That is: $H_0: u_1 = u_2$. The alternative hypotheses were: $H_1: u_1 > u_2$, $H_2: u_1 < u_2$. Table 10 contains the results of the tests.

All of the tests were significantly different at the 5 percent level except the results from the module on forage harvesting. The values of t were higher for the first five modules which indicates the null hypothesis should be rejected in each case. The computed t-value is higher than the table t-value at the 5 percent level for

Table 10.--Pretest vs. Post-test Performance.

Module	$t_{.05}$	Calculated t^*	Action
Plows	2.898	7.345	Reject H_0
Sec. Till.	2.120	4.828	Reject H_0
Planters	2.306	3.828	Reject H_0
Chem. App.	2.160	2.535	Reject H_0
Combines	2.160	2.611	Reject H_0
For. Harv.	1.860	.672	Fail to reject H_0

*Significant at the 5% level using paired t-test.

these modules which would indicate learning did occur through the use of these modules.

Since the t-value for the forage harvesting module was not greater than the t at the 5 percent level, I must fail to reject the null hypothesis that the two sets of test scores are not significantly different and conclude that the students' learning from this module was minimal. However, there were fewer pairs of pretest and post-test questions for this unit. The smaller sample size may result in a biased conclusion.

4.35 Comparison between sections of the 1975 class

As the various laboratory sections were made up by separating the class according to scores obtained on the placement test, it seemed desirable to check for variation in performance between the sections of the class. This was

done by running a one-way analysis of variance using the difference between the number of students getting the corresponding question right on the post-test.

The null hypothesis tested was that there was no significant difference between the sections, or $H_0: u_1 = u_2 = u_3 = u_4 = u_5$. The value of F obtained was 0.2818 and F-value from the table at the 5 percent level was 2.3719. Consequently, the null hypothesis could not be rejected. This supports the supposition that there was no significant difference in the performance of each section of the class. Since everyone took the same quizzes and tests, the conclusion reached is that each section performed equally well. This tends to support the practice of dividing students in a course according to their demonstrated knowledge of the subject at the beginning of the course.

4.4 Evaluation of the Course

4.41 Results of SIRS form

The Student Instructional Rating System (SIRS) form was used in 1975 to allow students to have an input into future revisions or developments on the course (AE 058). Only 61 of the 97 students chose to complete the form. Fourteen of those responding did not write any comments about the course. Seventy-six comments were taken from the 61 SIRS forms and are contained in Appendix I. These comments are grouped under five headings.

The first heading is concerned with the slide-tapes. Thirty-one percent of all the comments made were favorable to the use of slide-tapes as a method of presenting material. Only about 8 percent of the comments were unfavorable to the use of slide-tapes. Another 31 percent of the comments were grouped with regard to the post-tests and testing procedure. These students generally did not like the multiple-choice questions that had choices such as: all of the above, none of the above or two of the possible choices. Some respondents indicated they would have preferred taking the post-tests at set times, rather than choosing the time themselves.

The general feeling of a few of those in the 31 percent responding with regard to the post-tests was the test questions were too "tricky" or difficult to interpret. Only about one-sixth of all students enrolled in the course complained about the post-tests or final examination. The majority of all students apparently were not dissatisfied with the post-tests or method of testing.

The third group of comments are concerned with the laboratory activities and included about 8 percent of the comments. These included suggestions to make the lab exercises more demanding and more strictly supervised. Nineteen percent of the responses were placed in the fourth group. These were considered as generalities about the course because of the diversity of the points made by only one or two respondents on each topic. About 5 percent of the respondents advocated continuation of lectures. A few

complained about having to wait to view the slide tapes or to take post-tests. Since a time schedule was usually posted giving office hours, the validity of some of these complaints must be questioned. Two students felt that some test questions were not adequately covered by either the slide tapes or the text. As some laboratory material was included in the post-tests, this is possible.

The fifth broad heading included comments about the instructor. Only 4 percent of all the comments were addressed to the performance of the instructor. All of them were favorable as were two such comments about the course that were included under the heading of general comments.

Comments that provided suggestions about the course will be considered as further refinements are made before the material is used again by the author. The suggestion that more carrels be set up for future use and that the slide-tapes be made available at other locations on campus would help reduce waiting time for some students. Other students felt it would be desirable to have the post-tests given at set times each week. These students were critical about having to wait to take a post-test if no one was there to give them the test when they arrived.

4.42 Results of post-course survey

The audio-tutorial method of presenting instructional material is a departure from traditional teaching methods used for most courses of this nature. None of

these students had any prior experience with an audio-tutorial course. An evaluation was made to determine how those completing the course felt about their experience compared to the students who had taken the same course the year before with a traditional lecture-lab format.

One way of evaluating the effectiveness of a course is to survey those who have successfully completed it. A survey was constructed and was mailed to 25 randomly selected students from each of the 1974 class and the 1975 class. The survey was mailed in August 1975, about six months after the 1975 class started working. Only 14 graduates from the 1974 class and 19 graduates from the 1975 class returned the completed survey. A summary of the responses is shown in Appendix J.

The survey had two sections. The first section contained questions that were common to both classes. The second section contained questions about the slide-tapes and was sent only to the 1975 class. The questions in the first section were divided into three categories and those in the second section into four categories as shown in Table 11.

The first question was designed to determine the usefulness of the material covered in the course. The relevance of the course content to their work may be inferred from the fact that 48 percent of the respondents in the 1975 class have used the instructional material three or more times. This is true for 21 percent of those

Table 11.--Topical Breakdown of the Post Course Survey.

	Subject Covered	Questions on Survey
Section 1.	1. Usability of instructional material	1
	2. Post-course skills	2, 3, 4
	3. Management activities	5, 6, 7, 8, 9, 10, 11, 12
Section 2.	1. Attitudes toward slide-tapes	14, 19, 21
	2. Post-tests	16, 25, 26
	3. Laboratory activities	17, 27
	4. Objectives	18
	5. Technical quality of slide-tapes	22, 23, 24
	6. Availability and use of slide-tapes	15, 20

responding from the 1974 class. Of those responding, 71 percent of the 1974 class and 95 percent of the 1975 class have used this material at least once since starting to work. It appears that both groups realized there was information in the course material that was helpful to them.

Questions 2 through 6 were considered to represent skills needed after the course was completed. The respondents from both classes consistently rated themselves at the second highest level of performance rather than at the highest level. Either they did not judge these skills to be of prime importance or they have not yet developed these skills completely.

The third category consisted of questions dealing with management activities. It includes all the questions from 7 through 12.

Question number 7 received higher response in the no change column than the other possible choices. This was not surprising since the Attitude Assessment for the 1975 class (Appendix H, question 11) showed that the majority of students already recognized the importance of following a good preventive maintenance program.

The remaining five questions yielded some variation between the two classes with regard to their responses. Questions 8, 9, 11 and 12 were answered similarly by the 1974 class. Roughly a third of the responses were for each of the two highest choices and a third indicated no change from their previous habits.

This could be interpreted to mean that two-thirds of this group recognize the need for correct adjustments, good field layout and proper machine operation as well as the benefits to be gained from such practices. The other one-third generally felt there was no change in the way they operated or felt about these practices. It cannot be determined from their responses if they were already doing these in the desired way before taking the course, or if they do not accept these choices as the best way of doing their jobs.

The 1975 class responded differently. Almost half of them chose the most positive response for questions 8 and 9 which indicates they feel time spent making adjustments is justified. However, by selecting the second choice for questions 11 and 12, they are indicating they recognize efficiency can be kept at a high level when planning and performing their field work, but is not of ultimate concern all the time.

Question number 10 was answered more positively by the 1974 class. Their experience has apparently served to make them more cognizant of the importance of buying from good dealerships. Almost three-fourths of the respondents felt the dealership's reputation was of major importance. Only 7 percent felt the reputation of the dealership and its service was not of importance. The 1975 class did not feel as strongly about this with slightly less than 50 percent responding that it was of major importance. However, it is

possible that few of these graduates had an opportunity to purchase equipment in the six months after completing the course.

The second section of the survey form was sent only to those in the 1975 class as it related to their experience with the slide-tape modules. The questions are grouped into six topical areas as shown in Table 11, section 2.

The first area of concern deals with the students' attitudes toward the slide-tapes. Questions 14, 19 and 21 fall into this area. The majority of the students (95 percent) felt the slide-tapes were instructive. All the respondents liked using the instructional materials on their own time. However, almost three-fourths of the students would still like to have some lectures.

The second area covered by the survey was the post-tests for each module. Questions 16, 25 and 26 were about the post-tests. Approximately 95 percent of the students felt they were acceptable. Almost 80 percent felt they were of appropriate length and one-third of the respondents felt the questions on the quizzes should be made less difficult. Contrary to the responses on the SIRS forms (as shown in Appendix I), none of these students suggested eliminating the post-tests.

The laboratory activities were covered by questions 17 and 27. Over 60 percent of the students felt the laboratory activities were an important part of the learning activities and the rest of the students accepted them in a

positive manner also. In addition, the majority of the students (68 percent) felt the number of laboratory activities should be increased. Only 11 percent felt these activities should be decreased. This was an expected response as a number of comments on the SIRS forms also suggested that the difficulty level of the laboratory exercises should be increased (see Appendix I).

Only one question (number 18) was addressed to the objectives that were developed for each module. The intent was to determine if the students found them to be helpful in using the instructional materials. Almost 70 percent of the respondents indicated they felt the objectives were beneficial. However, a fourth of the students thought the objectives were not as helpful. They chose the response which stated the objectives were vague in their meaning. If these students did not understand how to use the objectives as a guide to studying, such a response would be expected. Perhaps further effort is needed in the future to ensure that more students know how to use the objectives as a guide to studying.

Three questions (22, 23 and 24) were used to find out how students felt about the instructional material used in the audio-tutorial part of the course. These asked specific questions about slides and tapes. Most of the tapes were under 20 minutes in length and 95 percent of the students felt there should not be a change in this. The same amount of students thought the slides were clear enough to show

what was being described. However, only about 80 percent of the students felt the clarity of the tapes was satisfactory. In view of the fact that the instructor made the tapes on a portable machine and did not use a sound studio, this is not surprising. Another factor is that the instructor had an accent different from the typical mid-western accent most of these students were accustomed to hearing.

The remaining two questions (15 and 20) were related as they were concerned with how many times students viewed each slide-tape and how they felt about the availability of the slide-tapes. Fifty-three percent of the students viewed each slide-tape two or more times. As the sets (five copies) were all at one location and were only available for viewing between 8:00 a.m. and 5:00 p.m., it is surprising the viewing rate was so high. Over half the respondents felt there should have been additional copies available at the same location. This means they felt more than five carrels should have been set up which would have reduced the waiting time for the whole class. Almost a fourth of the students responding thought it would have been helpful to have had the slide-tape sets available at other locations such as the main library. This would have allowed viewing during a greater number of hours also.

V. SUMMARY AND CONCLUSIONS

5.1 Summary

Agricultural Engineering 058, Farm Machinery, is a survey type course for two-year vocational students enrolled in the Institute of Agricultural Technology at Michigan State University. Students enrolled in the class have varying interests and abilities, both academically and vocationally. An audio-tutorial program of instruction was developed for use in 1975. The course material was presented through a slide-tape module format. Included in the format were: (1) statements of behavioral objectives; (2) pretests; (3) audio-tutorial presentations; (4) supplementary handout materials; (5) post-tests; and (6) laboratory exercises.

Comparisons were made between a class taught by traditional lecture methods (1974) and a class using the slide-tape modules (1975). The comparisons included entrance test scores, performance on the final examination, end of course grades and a Post Course Survey.

This study is limited to the Agricultural Engineering 058, Farm Machinery course, and the two-year Agricultural Technology students enrolled in it. This study is further limited to the development and presentation of the

learning modules utilized in the course and their effectiveness.

5.2 Conclusions

The results of this work are used as a basis for presenting the following conclusions:

1. There was no significant difference between the students entering the 1975 course and those entering the 1974 course.
2. Comparison of the 1975 class to the 1974 class showed that students using the slide-tape modules performed as well as those in the traditional lecture course.
3. Students indicated that they liked having statements of behavioral objectives to identify important concepts in course material.
4. A means of pacing students through the course should be used to encourage students to complete the course work within reasonable time spans.
5. Information given in the course is relevant to the "real world" situation as evidenced by the number of students using the course material for reference after completing the course.
6. Laboratory exercises should be strengthened to provide more information at a level of difficulty to match the degree of experience of the students in each laboratory section.

7. Past farming experience was not an important factor in the performance of students taking the course in the audio-tutorial format.

VI. RECOMMENDATIONS

Based on the results of this work, the following recommendations are made for future research and development with regard to audio-tutorial instructional programs for use in courses offered by Agricultural Engineering departments.

Research and development should be continued to:

1. Further develop A.E. 058 into a course with all the instructional material presented in audio-tutorial modules.
2. Develop each laboratory topic into multiple sections of varying degrees of difficulty. This should be done to provide a good understanding of farm machinery to students having no prior experience. Those students with a good background and experience in farm machinery would be placed in a section to provide greater depth to the same topic.
3. Develop a testing schedule to allow students to take post-tests at set times, thus freeing the instructor to work with students a greater percentage of his time.
4. Refine the post-test questions and expand the number of questions to build a pool of standardized

items. More than one version of each post-test should be available to students.

5. Create an awareness in other faculty members of the potential use of the instructional modules as supporting or supplemental material in other courses.
6. Gather data on student performance in the course and determine the relationship of student input time to performance.
7. Clarify existing material by eliminating ambiguities or adding additional explanations when needed.

Finally, it is recommended that other courses offered by Agricultural Engineering departments be developed in the audio-tutorial format. The audio-tutorial method of instruction appears to be well suited for presenting basic information to large numbers of students. The high amount of developmental effort and time would likely be justified by the additional amount of time gained by the instructor to work with students during the term.

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APPENDICES

APPENDIX A

APPENDIX A

Table A.1.--Schedule of Material Presentation.

Date	Topic	Assignment	Problems
Lectures:			
1/7	Power Trains: Gears, Belts & Pulleys, Shafts		
1/9	Power Trains: Chains & Sprockets, Clutches		
1/14	Hydraulics		
1/16	Hitches and PTO's		
1/21	Machine Performance	pp. 1-8,15-21	2,13,10
1/23	Power Performance	pp. 26-42	1,6,8
1/28	Labor Performance	pp. 45-48	
1/30	HOOR EXAM		
Slide Tapes:			
2/4	Primary Tillage	pp. 73-86	1,5
2/6	Primary Tillage	pp. 73-86	
2/11	Secondary Tillage	pp. 87-95	1,2
2/13	Secondary Tillage	pp. 87-95	
2/18	Planting Equipment	pp. 96-105	p.113:1,2,3
2/20	Chemical Applicators	pp. 105-114	7,8
2/25	Grain Harvesting	pp. 118-127	p.134:1
2/27	Grain Harvesting	pp. 127-133	6
3/4	Forage Harvesting	pp. 137-144	p.155:1,2
3/6	Forage Harvesting	pp. 144-154	4,6
3/12	Final Examination 8:00-10:00 PM		

Table A.2.--Farm Machinery Laboratory Schedule.

Date	Lab. No.	Topic
1/6-10	1	Conversions for Machinery Management
1/13-17	2	Transmission of Power through Machines
1/20-24	3	Hitches and Principles of Hitching
1/27-31	4	Machine Use Limitation
2/3-7	5	Tillage Equipment
2/10-14	6	Planter and Drill Calibration
2/17-21	7	Sprayers and Sprayer Calibration
2/24-28	8	Combines
3/3-7	9	Forage Harvesting Equipment

References for AE 058

Required Text:

1. Farm Power and Machinery Management, Donnell Hunt, Iowa State University Press, Ames, Iowa. 6th Ed.

Supplementary References:

1. Plows and Plowing, Ohio Agricultural Education, Curriculum Materials Services, 2120 Fyffe Road, Columbus, Ohio 43210
2. The Planter-Selection, Adjustment, Maintenance and Use, Vocational Agriculture Service, University of Illinois, 434 Mumford Hall, Urbana, Ill. 61801.
3. Fundamentals of Service - Mowing and Spraying Equipment, John Deere Service Publications, John Deere Road, Moline, Ill. 61265
4. Combines and Combining, Ohio Agricultural Education, Curriculum Materials Service, 2120 Fyffe Road, Columbus, Ohio 43210
5. Fundamentals of Machine Operation - Combine Harvesting, John Deere Service Publications, John Deere Road, Moline, Illinois 61265
6. Corn Pickers and Corn Picking, Ohio Agricultural Education, Curriculum Materials Service, 2120 Fyffe Road, Columbus, Ohio 43210

7. Choosing and Using Multi-purpose Sprayers, John Bean
Division, Lansing, Michigan 48910
8. Equipment Operators Manuals

APPENDIX B

APPENDIX B

Behavioral Objectives for Module on Plows

Based upon information presented in the slide tapes or text-book, when given a series of statements about plows or asked a question about plows either verbally or in written form, the student will be able to:

1. Select or state the reasons or advantages for using moldboard plows.
2. Explain the action of the plow when moving through the soil and resulting reaction of the soil forces on the plow.
3. Identify the various types and sizes of moldboard plows according to the intended use or power required for operation.
4. Name or identify the components of moldboard plows and accessories.
5. State or describe the function of moldboard plow parts or accessory parts as commonly used.
6. State the correct adjustment to be made when given a symptom of improper operation.

Behavioral Objectives for Module on Secondary Tillage

Based upon information presented in the slide tapes or text-book, when given a series of statements about tillage or asked a question about tillage, either verbally or in written form, the student will be able to:

1. Choose or give an acceptable definition of secondary tillage operations.
2. Enumerate the reasons for performing secondary tillage operations.

3. Identify the various kinds of implements used in secondary tillage operations.
4. Define the functions of the implements used in secondary tillage operations.
5. Describe or define the principles of operation of various secondary tillage implements.
6. Name the components of common secondary tillage implements.
7. Describe or define the function of components of secondary tillage implements.
8. Describe or name the kinds of adjustments that are required to give satisfactory operation of secondary tillage implements.
9. Explain why each adjustment causes the expected change of machine performance.

Behaviorial Objectives for Module on Planters

Based upon information presented in the slide tapes or textbook, when given a series of statements about planters, or asked a question about planters, by choosing the correct answer in a written or verbal form, the learner will be able to:

1. Specify the requirements of planting machines.
2. Differentiate between the various kinds of metering mechanisms.
3. Explain the principles of operation of planting machines.
4. State the name of the major components of planting machines.
5. Identify or describe the function of the major components of planting machines.
6. Defend in a positive manner the recommendation to calibrate planting and metering equipment before it is used.
7. State acceptable methods for calibrating seeding and metering equipment.

8. Explain the common types of adjustments required for good operation of planting equipment, and how to make them.

Behavioral Objectives for Module on Chemical Applicators

Based upon information presented in the slide tapes or textbook, when given a series of statements or asked a question about chemical applicators, by choosing the correct answer in a written or verbal form, the learner will be able to:

1. State the reasons for applying various kinds and forms of chemicals.
2. List the requirements of equipment to apply chemicals.
3. Identify the various kinds of chemical application equipment, according to the form of the chemical to be applied, or the operating characteristics of the applicator.
4. Explain the principles of operation of chemical applicators.
5. State the name and function of the components of chemical applicators.
6. Determine the adjustment to be made and the method for making the adjustment, when confronted with a situation representing a malfunction of the chemical applicator.
7. Justify the necessity to calibrate chemical applicators before use.
8. Explain or demonstrate an acceptable procedure to calibrate each of the various kinds of chemical applicators.

Behavioral Objectives for Module on Combines

Based upon information presented in the slide tapes or textbook, when given a series of statements or asked a question about combines, by choosing the correct answer in a written or verbal form, the learner will be able to:

1. Demonstrate his understanding of the necessity of good harvesting practices, considering those factors that affect the quality of the grain harvested.

2. Specify the optimum moisture levels for harvesting and storing corn, soybeans and small grains.
3. Identify the various kinds of combine harvesters.
4. Explain the differences between the various kinds of combines.
5. Name the major components of combine harvesters, when given a picture, the actual component or a description of the part.
6. State the function of the major combine harvester components.
7. List the characteristics of optimum performance and methods for determining the performance of combine harvesters.
8. Describe the procedures for measuring harvesting losses of combines.
9. Describe the adjustment to be made to correct improper performance or to reduce the harvesting losses.

Behavioral Objectives for Module on Forage Harvesting

Based upon information presented in the slide tapes or text-book, when given a series of statements or asked a question about forage harvesters, by choosing the correct answer in a written or verbal form, the learner will be able to:

1. Indicate the characteristics of typical forms of forages and their storage requirements.
2. Specify requirements of forage harvesting equipment according to the particular crop and amount to be harvested.
3. Select the components of a forage harvesting system best suited for specific types of crops.
4. Identify by name and/or function the main components of forage harvesting equipment.
5. Describe the function of the components of forage harvesting equipment.

6. Identify the operations and the principles of operation of machines used for harvesting forages.
7. Indicate the appropriate adjustments to be made to correct any given undesired performance of forage harvesting equipment.

APPENDIX C

APPENDIX C

Posttest for Module on Plows

Select the answer that represents the best choice and mark the appropriate letter on the answer sheet.

1. The primary reason for plowing is to:
 - a. control rodents
 - b. allow drainage
 - c. improve crop growing conditions
 - d. control insects
 - e. incorporate chemicals into the soil
2. The turned furrow slice should slope about:
 - a. 50 degrees from the furrow bottom (cw)
 - b. 90 degrees from the furrow bottom (cw)
 - c. parallel to the furrow wall
 - d. 70 degrees from the furrow wall (cw)
 - e. 130 degrees from the furrow bottom (cw)
3. The frog of the moldboard plow:
 - a. makes the vertical cut on the furrow wall
 - b. makes the horizontal cut on the furrow bottom
 - c. has all the plow bottom components bolted to it
 - d. bolts to the coulter
 - e. croaks in wet weather
4. Shortening the top link of an integral-mounted plow causes it to:
 - a. decrease penetration
 - b. increase penetration
 - c. cut a wide furrow slice
 - d. cut a narrow furrow slice
 - e. tilt toward the unplowed land
5. The component of a moldboard plow that inverts the soil is the:
 - a. shin
 - b. share
 - c. moldboard
 - d. point
 - e. landside

6. A semi-mounted plow is one that:
 - a. has all the weight carried on the plow wheels
 - b. has some of the weight carried on the tractor and some on the plow wheels
 - c. has all the weight carried on the tractor
 - d. may be hooked to the drawbar or carried by the 3-point hitch
 - e. none of the above
7. The rear wheels of a tractor used to plow should be adjusted:
 - a. as narrow as possible
 - b. as wide as possible
 - c. according to the location of the center of resistance
 - d. to whatever setting the operator wants
 - e. to half the width of cut
8. Rolling coulters:
 - a. cut trash
 - b. support the rear of the plow
 - c. counter-act the rotational forces for the entire plow (yawl)
 - d. invert the soil
 - e. all of the above
9. The share of a moldboard plow:
 - a. makes the vertical cut for the furrow slice
 - b. makes the horizontal cut for the furrow slice
 - c. cuts the trash on the surface of the soil
 - d. causes the trash to be covered
 - e. inverts the soil
10. A standard disc plow has:
 - a. all the discs mounted on a single axle
 - b. notched discs
 - c. each disc mounted on its own supporting standard
 - d. a fluted coulter
 - e. two bottoms only
11. Traction assisting control systems:
 - a. increase the weight on the rear wheels when the draft increases
 - b. lift the plow slightly when the draft increases
 - c. do not allow the plow to float in a balanced condition
 - d. all of the above
 - e. none of the above

12. The center of resistance of a typical moldboard bottom, in average soil, is located how far to the right of the landside?
 - a. $\frac{2}{3}$ the width of cut
 - b. $\frac{1}{2}$ the width of cut
 - c. $\frac{1}{3}$ the width of cut
 - d. $\frac{1}{4}$ the width of cut
 - e. $\frac{1}{6}$ the width of cut
13. The coulter should be positioned horizontally, in relation to the landside:
 - a. to the left
 - b. directly in line
 - c. to the right
 - d. lower than the landside
 - e. none of the above
14. Moldboard plows having a rear wheel will usually have the rear landside:
 - a. shorter than the other landsides
 - b. same length as the other landsides
 - c. longer than the other landsides
 - d. removed from that plow bottom
 - e. none of the above
15. If the crossshaft of an integral plow is rotated slightly, the resulting change in the total plow setting will be to:
 - a. raise the rear of the plow
 - b. change the tilt from side to side only
 - c. change the alignment only
 - d. change both the side to side tilt and the alignment
 - e. raise the front of the plow only
16. The gauge wheel used on integral or semi-integral plows:
 - a. marks the line for making the next furrow
 - b. carries the weight of the rear of the plow
 - c. prevents plowing deeper than the preset depth
 - d. counteracts the rotational forces
 - e. measures the width of cut
17. The width of cut of a moldboard plow is measured by:
 - a. measuring the length of the share
 - b. measuring the horizontal distance between the landsides of two adjacent bottoms
 - c. measuring the length of the moldboard
 - d. measuring the vertical distance from the point of the frame
 - e. measuring the distance between the coulter and the shin

18. Worn plow points result in:
 - a. difficult penetration
 - b. increases in the draft
 - c. uneven depth of plowing
 - d. all of the above
 - e. none of the above
19. The center of resistance of a four bottom, 16 inch moldboard plow is located:
 - a. 28 inches to the left of the right-hand moldboard tip
 - b. 28 inches to the right of the left-hand landside
 - c. 36 inches to the right of the left-hand landside
 - d. 32 inches to the left of the right-hand moldboard tip
 - e. 32 inches to the right of the left-hand landside
20. If the front of the tractor tends to pull to the right when plowing, the plow needs to:
 - a. be aligned
 - b. be leveled side to side
 - c. have the rear lowered
 - d. have the rear raised
 - e. have the coulter readjusted

Posttest for Module on Secondary Tillage

Select the answer that represents the best choice and mark the appropriate letter on the answer sheet.

1. Notched concave discs are found on:
 - a. springtooth harrows
 - b. cultivators
 - c. disc harrows
 - d. spiketooth harrows
 - e. none of the above
2. Sweeps are used on:
 - a. springtooth harrows
 - b. cultivators
 - c. disc harrows
 - d. spiketooth harrows
 - e. all of the above
3. Secondary tillage is defined as:
 - a. tillage operations greater than 18 inches
 - b. tillage operations greater than 12 inches
 - c. tillage operations greater than 6 inches
 - d. tillage operations less than 6 inches
 - e. none of the above
4. Lowering the hitch point of a disc harrow causes it to:
 - a. penetrate more deeply
 - b. penetrate less deeply
 - c. increase the cutting angle
 - d. decrease the cutting angle
 - e. none of the above
5. The main function of a sweep on a field cultivator is to:
 - a. cover the surface trash
 - b. throw soil into the plant row to smother weeds
 - c. cut weed roots over a wide path
 - d. open the soil to allow seed to be placed at the correct depth
 - e. none of the above
6. The teeth of a springtooth harrow are effective because they:
 - a. vibrate while moving through the soil and cause the soil to break up
 - b. are very rigid and do not flex
 - c. have wide wings at the tip to cover the area between them
 - d. can be adjusted easily to give various spacings between the teeth
 - e. none of the above

7. If the setting of the angle of the gangs of a disc harrow are increased:
 - a. the soil will be turned more
 - b. the penetration will decrease slightly
 - c. the disc will level the land better
 - d. all of the above
 - e. none of the above
8. The depth of penetration of a field cultivator may be controlled:
 - a. by a hydraulic system
 - b. by using depth wheels
 - c. by changing the rake angle
 - d. all of the above
 - e. none of the above
9. As forward speed is increased, the draft on tillage implements (except disk harrows):
 - a. increases
 - b. remains the same
 - c. decreases
 - d. becomes insignificant
10. Which of the following factors affect the penetration of a disc harrow?
 - a. spacing between disc blades
 - b. diameter of disc blades
 - c. total weight
 - d. all of the above
 - e. none of the above
11. When preparing a seedbed in rocky soils after plowing, use a:
 - a. disc harrow
 - b. springtooth harrow
 - c. field cultivator
 - d. rotary hoe
 - e. none of the above
12. The disc harrow can be used to:
 - a. cover trash and stubble, break clods, help compact soil
 - b. loosen compacted soil, break clods, control weeds
 - c. level plowed land, mix fertilizer into soil
 - d. all of the above
 - e. none of the above

13. The field cultivator can be used to:
 - a. cover trash and stubble, break clods, compact soil
 - b. loosen compacted soil, break clods, control weeds
 - c. replace double disc furrow openers on grain drills
 - d. all of the above
 - e. none of the above
14. Disc blades pulverize the soil because:
 - a. the impact of the disc blade throws the soil in all directions
 - b. the curvature of the disc blade and its trailing edge cause the soil to be lifted, broken, and turned
 - c. the sharp edge cuts the soil into fine particles
 - d. all of the above
 - e. none of the above
15. The cultipacker should be used:
 - a. to form the seedbed
 - b. in place of a field cultivator
 - c. to destroy weeds
 - d. all of the above
 - e. none of the above
16. The cultivator tools that have no wings are called:
 - a. half-sweeps
 - b. sweeps
 - c. shovels
 - d. all of the above
 - e. none of the above
17. The primary problems in adjusting a row crop cultivator are:
 - a. obtaining uniform depth and optimum throwing of soil into the row of plants
 - b. correct rake angle and forward speed
 - c. correct selection of tools and even penetration
 - d. correct tool selection and optimum throwing of soil into the row of plants
 - e. all of the above
18. Except for adjusting spiketooth harrows for proper trash clearance, the only adjustment is for:
 - a. set of the tool
 - b. desired penetration
 - c. amount of soil thrown
 - d. spacing between the rows

19. In addition to eliminating weeds, other reasons for cultivating are to:
- a. aerate the soil
 - b. provide support for plants
 - c. incorporation of chemicals
 - d. all of the above
 - e. none of the above
20. When preparing seedbeds, besides reducing soil particle size, other objectives are:
- a. invert the surface of the soil and kill weeds
 - b. leave a level surface and kill weeds
 - c. leave a loose surface and level surface
 - d. all of the above
 - e. none of the above

Posttest for Module on Planters
and Grain Drills

Select the answer that represents the best choice and mark the appropriate letter on the answer sheet.

1. The soil opener best suited for rocky soils is:
 - a. runner type
 - b. single disc type
 - c. double disc type
 - d. hoe type
2. Individual seeds are held in the metering mechanism of a cyclo planter by:
 - a. gravity
 - b. spring pressure on a small lever
 - c. air pressure differential on opposite sides of the seed
 - d. none of the above
3. In the plateless planter, to increase the number of seeds planted per acre:
 - a. increase the speed of the seed plate
 - b. increase forward speed
 - c. increase the RPM of the finger wheel
 - d. increase the RPM of the seed drum
4. A planter that is used to hill drop seeds is one that:
 - a. drops seeds one at a time at specific spacings
 - b. drops more than one seed at specific intervals
 - c. must have a mound of soil in which to drop the seed
 - d. is designed for use on sloping ground
5. The metering mechanism for applying fertilizer with a corn planter:
 - a. is the same mechanism that meters the seeds
 - b. must be calibrated separately from the seed metering mechanism
 - c. will always be correctly adjusted when the seed metering mechanism is calibrated
6. Which of the following factors may affect the planting rate of any corn planter?
 - a. variation of seed size
 - b. speed of rotation of metering mechanism
 - c. depth of seed in hopper
 - d. all of the above

7. A unit planter is one that:
 - a. is a complete seed planting mechanism, self-contained
 - b. is mounted onto a tool bar
 - c. has the capability of being spaced at different row spacings
 - d. all of the above
8. Larger multiple-row plate-type planters are limited in their speed of operation by:
 - a. turbulence in the seed hopper
 - b. excessive draft
 - c. poor covering of the seeds
 - d. all of the above
9. A four row planter, with 30 inch row spacings, averaged 245 seeds per row over a test distance of 217.8 ft. The number of seeds planted per acre will be approximately:
 - a. 19,600 seeds per acre
 - b. 18,200 seeds per acre
 - c. 16,000 seeds per acre
 - d. 14,900 seeds per acre
10. A grain drill that carries the designation 17 x 7 is one that:
 - a. plants 17 rows, and is 7 feet wide
 - b. plants 7 rows and is 17 feet wide
 - c. plants 17 rows, 7 inches apart
 - d. plants 7 rows, 17 inches apart
11. The total width covered by a 17 x 7 grain drill would be:
 - a. 119 inches
 - b. 7 feet
 - c. 17 feet
 - d. 24 feet
12. The metering mechanism of grain drills are commonly powered from:
 - a. auxiliary engines
 - b. PTO drivers
 - c. ground wheels
 - d. all of the above
13. The star-wheel metering mechanism is used to meter:
 - a. small grain
 - b. corn
 - c. granular fertilizer
 - d. liquid fertilizer

14. The fluted feed metering mechanism is used to meter:
 - a. small grain
 - b. corn
 - c. granular fertilizer
 - d. liquid fertilizer
15. The double internal run metering mechanism is used to meter:
 - a. small grain
 - b. corn
 - c. granular fertilizer
 - d. liquid fertilizer
16. The amount of material delivered by a fluted-feed metering mechanism may be changed by adjusting:
 - a. the drive gear ratio
 - b. the length of the fluted cylinder exposed to the material
 - c. the setting of an adjustable gate under the fluted cylinder
 - d. all of the above
17. A grain drill can be used to plant:
 - a. small grain
 - b. forage crops
 - c. soybeans
 - d. all of the above
18. Grain drills may use which of the following types of soil openers:
 - a. single-disc opener
 - b. runner opener
 - c. hoe opener
 - d. all of the above
19. Grain drills may use which of the following to cover the seed:
 - a. drag chains or sweeps
 - b. drag chains or press wheels
 - c. press wheels or sweeps
 - d. press wheels or double discs
20. Grass seed hoppers mounted on grain drills meter the seed by:
 - a. fluted-feed mechanisms or variable orifice mechanisms
 - b. variable orifice mechanisms or star-wheel mechanisms
 - c. fluted-feed mechanisms or star-wheel mechanisms
 - d. none of the above

Posttest for Module on Chemical Applicators

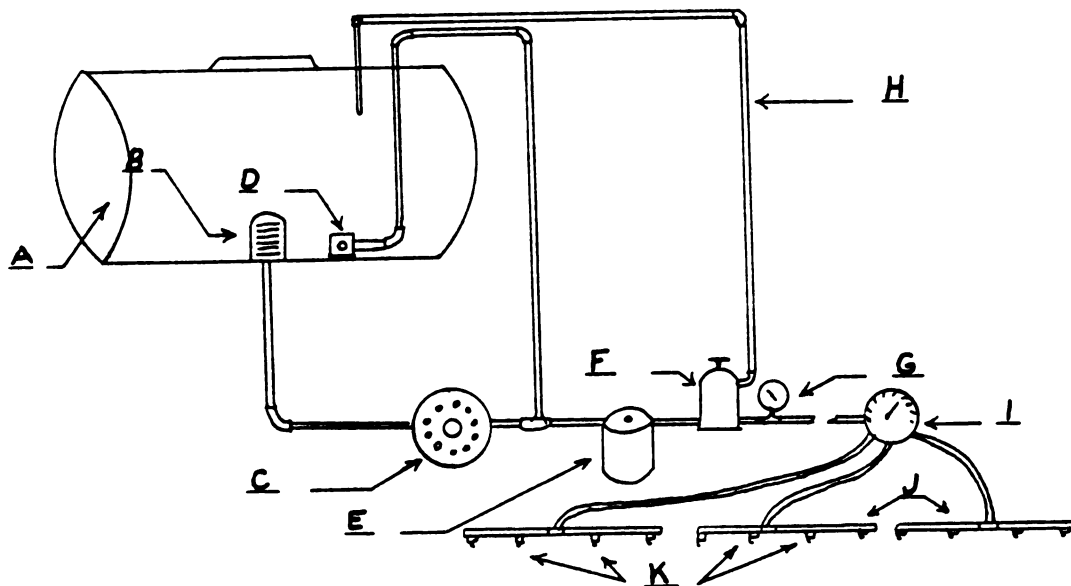
Select the answer that represents the best choice and mark the appropriate letter on the answer sheet.

1. Materials commonly used as fertilizers in agriculture are available in which of the following forms?
 - a. solids and gases only
 - b. solids and liquids only
 - c. liquids and gases only
 - d. solids only
 - e. solids, liquids and gases
2. Materials used as pesticides commonly are applied as:
 - a. solids and gases only
 - b. solids and liquids only
 - c. liquids and gases only
 - d. solids, liquids and gases
 - e. liquids only
3. Chemicals are used in agriculture for:
 - a. fertilizers and insect control
 - b. weed control and food preservation
 - c. nutritional supplements and medication
 - d. all of the above
 - e. a and b only
4. Dry fertilizer materials may be applied by:
 - a. broadcast methods (on surface)
 - b. drilled (below the soil surface)
 - c. banded (below the soil surface)
 - d. mixed into the soil
 - e. all of the above
5. A broadcast type chemical applicator applies the chemical by:
 - a. "throwing" it on the soil surface over a wide area
 - b. metering it onto the soil surface in narrow bands
 - c. placing it under the soil by use of some type of soil opener
 - d. mixing it into the soil
 - e. none of the above
6. Most common applications of gaseous chemicals used in the field are done by:
 - a. releasing a vapor (gas) into the air near the plants
 - b. releasing a vapor (gas) under the soil
 - c. dissolving the gas in water and the spraying on the liquid
 - d. a and b only
 - e. all of the above

7. Droplet size of a liquid forced from a nozzle will:
 - a. not change with an increase in pressure
 - b. increase with an increase in pressure
 - c. decrease with an increase in pressure
 - d. depend upon the pump capacity
 - e. increase with the speed of the pump
8. The nozzle of a sprayer serves to:
 - a. determine the spray pattern
 - b. control droplet size
 - c. control the volume of liquid applied per unit of time
 - d. all of the above
 - e. A & C only
9. To get the desired coverage of the surface being sprayed with even spray nozzle tips, the nozzles should be spaced to get:
 - a. no overlap (patterns just meeting)
 - b. $1/4$ width overlap
 - c. $1/3$ width overlap
 - d. $1/2$ width overlap
 - e. between b and c
10. If the operating pressure is increased after calibration, the sprayer will:
 - a. not be affected
 - b. deliver less spray per acre
 - c. deliver more spray per acre
 - d. stop working
 - e. automatically change pump speed
11. The distance a particle of granular fertilizer can be thrown depends on:
 - a. its density and shape
 - b. the speed of rotation of the spinner and the angle of the spinner blades
 - c. its initial placement location on the spinner and the amount being metered
 - d. all of the above
 - e. b and c only
12. A dry chemical being applied as a dust is placed by:
 - a. a free fall from the metering device
 - b. centrifugal action from a spinner
 - c. being carried on an air stream
 - d. all of the above
 - e. b and c only

13. Herbicides are applied as:
- liquids
 - liquids or granules
 - liquids or powders
 - powders or granules
 - liquids, powders and granules
14. Dusters commonly use which type of metering device?
- variable orifice
 - star wheel
 - fluted feed
 - double internal run
 - spinner
15. Which of the following affect the rate of output of a granular applicator?
- size range of particles and depth in hopper
 - levelness of hopper and agitator speed
 - amount of compaction in the hopper
 - all of the above
 - a and c only

The following diagram shows the components of a typical agricultural sprayer, with the components labeled with letters.



16. Part A is used to:
 - a. mix the chemicals
 - b. receive the overflow from the pump
 - c. hold the chemical solution for spraying
 - d. all of the above
 - e. b and c only
17. Part C is the:
 - a. line filter
 - b. pump
 - c. pressure regulator
 - d. boom selector
 - e. strainer
18. The device that keeps the chemical mixed during use is:
 - a. C
 - b. D
 - c. F
 - d. I
 - e. B
19. The function of F is to:
 - a. maintain the desired operating pressure
 - b. remove large particles from the liquid
 - c. select the section of the spray boom to be used
 - d. mix the chemicals during sprayer operation
 - e. show the operation pressure
20. The component used to indicate the working pressure is:
 - a. F
 - b. I
 - c. G
 - d. C
 - e. E
21. The nozzle strainers (to prevent the nozzles from clogging up) are located at:
 - a. K
 - b. E
 - c. I
 - d. B
 - e. F
22. Which of the following is considered to be a non-positive displacement pump?
 - a. impeller type
 - b. diaphragm type
 - c. centrifugal type
 - d. all of the above
 - e. a and c only

23. Flooding type nozzle tips are used under conditions requiring applications:
 - a. at low pressure
 - b. at high volume
 - c. with little drift
 - d. complete coverage
 - e. all of the above
24. If the height of the boom above ground is increased after calibration, the amount of spray material deposited per unit of plant leaf area will be:
 - a. unaffected
 - b. increased
 - c. decreased
 - d. compensated for by droplet size
 - e. none of the above
25. Pumps used on agricultural sprayers are:
 - a. nonpositive displacement and high pressure
 - b. nonpositive displacement and low pressure
 - c. positive displacement and high pressure
 - d. positive displacement and low pressure
 - e. may be either positive or nonpositive displacement
26. Broadcast spreaders used to spread bulk fertilizer usually use which type of metering system?
 - a. variable oriface
 - b. star wheel
 - c. fluted-feed
 - d. double internal run
 - e. b or c only
27. A field distributor places fertilizer by:
 - a. "throwing" it on the soil surface over a wide area
 - b. metering it onto the soil surface in narrow bands
 - c. placing it under the soil by means of some type of soil opener
 - d. mixing it into the soil with a tool
 - e. a and d only
28. The fertilizer section of a grain drill usually uses what kind of metering mechanism?
 - a. variable oriface
 - b. star wheel
 - c. fluted-feed
 - d. double internal run
 - e. a or b

29. In addition to knowing the nozzle size, spacing and height above the surface to be sprayed, what other factors must be known to allow calibration of chemical sprayers in terms of gallons per acre?
- application rate per acre, operating pressure and rate of speed
 - application rate per acre, pump capacity and forward speed
 - forward speed, kind of pump and application rate per acre
 - kind of chemical, pump capacity and diameter of boom
 - all of the above
30. Using the formula, $\text{GPA} \times \text{MPH} \times \text{W}/5940 = \text{GPM/Nozzle}$, what size nozzle would be required to apply 18 gallons per acre at 3.5 miles per hour with the nozzle spaced 20 inches apart for 40 acres?
- .17
 - .21
 - .29
 - .36
31. The maximum allowable variation of output between nozzles on a farm sprayer is:
- 4%
 - 6%
 - 10%
 - 15%
 - between A and C
32. Using the formula $\frac{\text{No.} \times 200}{\text{W}} = \text{gal/acre}$, what is the application rate when a sprayer is operated over a distance of 163 $\frac{1}{3}$ feet at 3 mph and 4.5 cups of liquid are sprayed with the nozzles 18 inches on center.
- 50 gal/acre
 - 40 gal/acre
 - 30 gal/acre
 - 25 gal/acre
 - 20 gal/acre

Posttest for Module on Combines

Select the answer that represents the best choice and mark the appropriate letter on the answer sheet.

1. Loose grain is removed from the straw and chaff at the:
 - a. cylinder and concaves only
 - b. straw rack only
 - c. cylinder and concaves and the seives
 - d. cylinder and concaves, the grate under the beater and the straw rack
 - e. cylinder and concaves, and the straw chopper
2. The tailings auger carries:
 - a. unthreshed grain heads to the seives
 - b. threshed grain to the tank
 - c. unthreshed grain to the cylinder and concaves
 - d. unthreshed grain to the straw rack
3. When harvesting corn with combines, the:
 - a. cobs are always broken into small pieces
 - b. husks are completely removed from the cob
 - c. entire corn stalk passes through the cylinder and concaves
 - d. cobs always pass through the combine unbroken
 - e. cobs never enter the combine
4. When harvesting soybeans, the cutter bar:
 - a. should be adjusted as close to the ground as possible
 - b. should be adjusted to the same height as for wheat
 - c. should be operated twice as fast as for wheat
 - d. should be operated one-half as fast as for corn
 - e. none of the above
5. When harvesting small grain with a combine, the grain is removed from the heads:
 - a. at the reel and cutter bar
 - b. at the cylinder and concaves
 - c. on the straw walker
 - d. on the seive
 - e. c and d
6. The reel bats should contact the standing small grain:
 - a. as close to the ground as possible
 - b. halfway up the total height of the plant
 - c. slightly below the grain heads
 - d. on the grain heads
 - e. the position of contact is unimportant

7. The straw walker has the function of:
 - a. moving the straw out of the machine
 - b. spreading the straw evenly on the ground behind the combine
 - c. shaking loose grain from the straw
 - d. all of the above
 - e. a and c
8. The fan must be adjusted to:
 - a. blow the straw out of the combine
 - b. blow dirt out of the grain
 - c. blow the chaff and weed seeds out of the grain
 - d. blow the grain into the auger
 - e. create a suction through the seives
9. During harvest of wheat, it is observed that loose grain is uniformly scattered over the field behind the combine. This loss is:
 - a. cutter bar loss
 - b. separating (rack) loss
 - c. cylinder loss
 - d. shatter (pre-harvest) loss
 - e. cleaning loss
10. One typical classification of combines is:
 - a. PTO powered, hillside, self-propelled
 - b. prairie, hillside, auxiliary powered
 - c. PTO powered, auxiliary powered, self-propelled
 - d. prairie, narrow cylinder, hillside
 - e. none of the above
11. The recommended moisture levels for harvesting and storing wheat are, harvest:
 - a. at 14%, store below 14%
 - b. at 20%, store at 14%
 - c. above 20%, store at 20%
 - d. above 30%, store below 20%
 - e. at 10%, store at 8%
12. The reel of a small grain combine should turn at approximately:
 - a. same as forward speed
 - b. 1.25 times forward speed
 - c. 1.50 times forward speed
 - d. 2.0 times forward speed
 - e. from b to c.

13. When harvesting soybeans, the cylinder speed is adjusted according to:
 - a. the height of the plants
 - b. the moisture content of the beans
 - c. the size of the beans
 - d. all of the above
 - e. b and c
14. The common types of cylinder and concave designs are:
 - a. raspbar, rub bar, slats
 - b. spike-tooth, rub bar, slats
 - c. spike-tooth, rub bar, raspbar
 - d. spike-tooth, raspbar, slats
 - e. slats, solid and spike-tooth
15. A self-propelled hillside combine automatically:
 - a. levels the main part of the combine
 - b. levels the main part of the combine front to rear
 - c. allows the cutting head to follow the contour of the ground
 - d. all of the above
 - e. a and c
16. The mechanisms of a combine have the functions of:
 - a. feeding, threshing, cleaning, storing
 - b. cutting, threshing, separating, cleaning, storing
 - c. cutting, feeding, threshing, separating, cleaning
 - d. cutting, feeding, threshing, separating, storing
 - e. cutting, feeding, threshing, separating, cleaning and storing.
17. A large amount of cracked grain appears in the grain tank.
 - a. adjust height of reel
 - b. adjust fan opening
 - c. adjust cylinder-concave clearance
 - d. adjust beater speed
 - e. adjust chaffer setting
18. High amounts of loose grain are present in the tailings return auger. This indicates:
 - a. shoe sieve openings are too small
 - b. shoe sieve openings are too large
 - c. fan opening too small
 - d. chaffer openings too large
 - e. tailboard adjusted too low

19. The cutting mechanism of a grain combine is:
 - a. a flail type cutter
 - b. a rotary type cutter
 - c. a reciprocating type cutter
 - d. none of the above
 - e. b or c

20. The recommended moisture levels for harvesting and storing soybeans are:
 - a. harvest after grain first drops below 20%, store at same
 - b. harvest after grain first drops below 18%, store at same
 - c. harvest after grain first drops below 15%, store at same
 - d. harvest after grain first drops below 13%, store at same
 - e. harvest after grain first drops below 10%, store at same

Posttest for Module on Forage Harvesting

Select the answer that represents the best choice and mark the appropriate letter on the answer sheet.

1. Corn silage is made by:
 - a. removing the ears of corn from the stalks, shelling it and storing the grain at high moisture levels
 - b. cutting the entire corn plant and baling it
 - c. finely chopping the entire corn plant and storing it in the absence of air
 - d. cutting the corn plant, allowing it to wilt in the field, then storing it in a barn
 - e. cutting the crop before the ears form and storing it in a pile
2. The common equipment used to make corn silage is:
 - a. reciprocating mower, rake, chopper, self-unloading wagon, tractor
 - b. self-propelled windrower, baler, self-unloading wagon, tractor
 - c. chopper, self-unloading wagon, tractor
 - d. mower-conditioner, self-unloading wagon, tractor
 - e. chopper, mower-conditioner, self-unloading wagon
3. Typical forage harvesters consist of:
 - a. a basic chopping and elevating unit and a head
 - b. a basic chopping unit and a separator
 - c. a basic chopping unit and a compressing unit
 - d. a power source and a screen
 - e. b and c
4. Forage harvesters may be:
 - a. self-propelled
 - b. semi-mounted
 - c. trailing
 - d. all of the above
 - e. a and c
5. The chopping mechanism of forage harvesters may be:
 - a. radial (flywheel) type, cylindrical (helical) type or hammer (flail) type
 - b. cylindrical (helical) type, reciprocating type or hammer (flail) type
 - c. radial (flywheel) type, reciprocating type or hammer (flail) type
 - d. reciprocating type or rotary type
 - e. cylindrical type only

6. Forage choppers may be equipped with which of the following heads?
 - a. row crop, cutter bar
 - b. windrow pick-up, cutter bar
 - c. windrow pick-up, row crop
 - d. cutter bar, row crop, windrow pick-up
 - e. none of the above
7. A cylinder type forage harvester allows for changes in the cutting length of the silage material by:
 - a. adding or removing knives and change of forward speed
 - b. changing the speed of the feed mechanism and changing forward speed
 - c. changing the number of knives and changing the speed of the feed mechanism
 - d. all of the above
 - e. a and b
8. A row-crop header on a forage harvester separates the stalk of the plant from the roots by:
 - a. using a reciprocating mower
 - b. using a rotary mower
 - c. breaking the stalk off at ground level
 - d. all of the above
 - e. a and b
9. The greatest factors causing high power requirements of forage harvesting are:
 - a. forward speed and shortness of cut
 - b. speed of cutter mechanism and shortness of cut
 - c. forward speed and speed of cutter mechanism
 - d. sharpness of cutter mechanism and condition of crop
 - e. b and d
10. The maintenance of forage harvesters to have optimum cutting action involves two very critical points of service which are:
 - a. sharpness of cutting units and lubrication of the drive mechanism
 - b. sharpness of cutting units and clearance between the cutting units and the shear bar
 - c. lubrication of the drive mechanism and forward speed
 - d. clearance between the cutting unit and the shear bar and balance of rotating parts
 - e. sharpness of cutting units and balance of rotating parts

11. To reduce the amount of power needed to make silage:
 - a. operate the cutter head at as slow a speed as possible
 - b. operate the cutter head at as fast a speed as possible
 - c. use as many knives as possible
 - d. chop the plant material as long as possible
 - e. a, c, and d
12. Which of the following have been used to move chopped forage into the wagon?
 - a. a drag chain
 - b. "thrown" by cutting mechanism
 - c. carried on an air stream
 - d. all of the above
 - e. b and c
13. Many forage harvesters have clutches and reversing mechanisms on them to:
 - a. help prevent clogging
 - b. allow on the machine sharpening of the chopper knives.
 - c. provide a safety feature
 - d. all of the above
 - e. a and c
14. The placement of the chopped forage into the wagon (to the front or back) is controlled by:
 - a. changing the amount of air used to blow the chopped material
 - b. reducing the speed of rotation of the blower unit
 - c. changing the position of a deflector on the discharge chute
 - d. all of the above
 - e. b and c
15. The term "green chop" refers to forage that will be:
 - a. chopped and put directly into a silo
 - b. cut, allowed to wilt on the ground for a period of time, then chopped before being put in a silo
 - c. chopped and fed to livestock soon after cutting
 - d. cut and allowed to dry before being chopped and fed to livestock
 - e. c and d
16. When haylage is put into a silo, a cylinder or flywheel type forage harvester is commonly used with:
 - a. a windrow pick-up head
 - b. a cutter bar type head
 - c. a row crop head
 - d. all of the above
 - e. a and c

17. When compared to a sharp cutting edge, one that has dulled to 1/64th of an inch on the chopping unit requires approximately:
- a. 3 times as much power
 - b. 2 times as much power
 - c. 1 1/2 times as much power
 - d. same amount of power
 - e. none of the above
18. The forage for silage should be reduced in size in the forage harvester by a:
- a. crushing action
 - b. shearing action
 - c. twisting action
 - d. squeezing action
 - e. compressing action

APPENDIX D

APPENDIX D

Pretest

Select the answer that represents the best choice and mark the appropriate letter on the answer sheet.

1. A disk harrow usually uses:
 - a. spring teeth
 - b. shovels
 - c. spikes
 - d. concave disks
 - e. none of the above
2. Planters for small grain (grain drills) meter the seed by:
 - a. fluted-feed metering mechanism
 - b. variable speed augers
 - c. star wheels
 - d. centrifugal feeder
 - e. all of the above
3. The part of the moldboard plow bottom that holds the other pieces together is the:
 - a. moldboard
 - b. standard
 - c. beam
 - d. frog
 - e. main bolt
4. An integral plow is one that:
 - a. has one bottom
 - b. uses concave disks
 - c. is mounted on the tractor (3-point hitch)
 - d. hooks to the drawbar
 - e. has some of the weight carried on a tailwheel
5. Older type (conventional) corn planters meter seeds by:
 - a. star wheel metering mechanisms
 - b. rotating plates
 - c. rotating drums
 - d. finger wheels
 - e. all of the above

6. The metering mechanism of conventional corn planters is operated from:
 - a. PTO drive
 - b. auxiliary engine drive
 - c. ground wheel drive
 - d. all of the above
 - e. None of the above
7. Cultivators usually use:
 - a. spikes
 - b. concave disks
 - c. shovels
 - d. moldboards
 - e. none of the above
8. Secondary tillage operations are:
 - a. 0" to 3" deep
 - b. 0" to 6" deep
 - c. 6" to 12" deep
 - d. 6" to 18" deep
 - e. none of the above
9. Increasing the cutting angle of a disk harrow causes it to:
 - a. reduce penetration
 - d. decrease draft
 - c. turn the soil more
 - d. turn the soil less
 - e. act as a subsoiler
10. When plowing, the furrow slice should be turned:
 - a. completely upside down
 - b. 130 degrees
 - c. 90 degrees
 - d. 45 degrees
 - e. 30 degrees
11. The criteria used to set the rear wheel spacing of a tractor before plowing may include:
 - a. number of plow bottoms
 - b. location of the center of resistance
 - c. number of rear tires
 - d. physical size of the tractor
 - e. all of the above
12. A sweep:
 - a. covers surface trash
 - b. turns a furrow
 - c. cuts weed roots over a wide area (6" or more)
 - d. works the soil in a narrow strip (4" or less)
 - e. turns a furrow slice

13. The total width of coverage of an 18 x 6 grain drill is:
 - a. 18 feet
 - b. 6 feet
 - c. 108 inches
 - d. 216 inches
 - e. none of the above
14. Plowing is usually done to:
 - a. control rodents
 - b. improve crop growing conditions
 - c. hold water
 - d. prevent erosion
 - e. none of the above
15. The function of the share is to:
 - a. cut the furrow wall
 - b. invert the soil
 - c. control depth
 - d. cut the bottom of the furrow slice
 - e. firm the furrow wall
16. Which of the following metering mechanisms is not used to meter fertilizer?
 - a. star wheel
 - b. variable oriface
 - c. double internal run
 - d. auger
 - e. all of the above
17. A planter used to plant corn must have which of the following components:
 - a. seed metering mechanism, fertilizer metering mechanism, hoppers
 - b. seed metering mechanism, hopper, soil opener
 - c. seed metering mechanism, hopper, soil opener, press wheel
 - d. seed and fertilizer metering mechanisms, hoppers, press wheels
 - e. none of the above
18. Change in forward speed will cause:
 - a. no change in draft with increase of speed
 - b. decrease in draft with increase of speed
 - c. increase in draft with increase of speed
 - d. increase in draft with decrease of speed
 - e. none of the above

19. What part of the plow ensures a clean top edge of the furrow wall?
 - a. moldboard
 - b. coulter
 - c. shin
 - d. landside
 - e. heel
20. A cultivator is used to:
 - a. cultivate row crops
 - b. do subsoiling work
 - c. prepare a seed bed
 - d. list the land
 - e. all of the above
21. To make a mounted plow tilt downward at the front:
 - a. raise the depth wheel
 - b. lower the hitch point
 - c. shorten the top link
 - d. lengthen the top link
 - e. raise the hitch point
22. Cultivation is done to eliminate weeds and:
 - a. provide support for plants
 - b. mix chemicals into soil
 - c. aerate the soil
 - d. all of the above
 - e. none of the above
23. Which of the following factors may affect the planting rate of any corn planter?
 - a. forward speed
 - b. speed of rotation of the metering mechanism
 - c. depth of seed in the hopper
 - d. variation of seed size
 - e. all of the above
24. A plate-type corn planter may be operated:
 - a. 1.5-4.0 mph
 - b. 2.5-5.0 mph
 - c. 3.5-6.0 mph
 - d. 4.5-7.5 mph
 - e. 5.5-8.5 mph
25. A change in rake angle causes a tool to:
 - a. operate at a different depth
 - b. throw soil further with a decrease in angle
 - c. change its draft
 - d. all of the above
 - e. none of the above

26. A disk plow having separate axles for each disk blade is called:
 - a. a standard disk plow
 - b. a vertical disk plow
 - c. a rolling plow
 - d. a soft ground plow
 - e. a 2-way plow
27. A six-row corn planter set for 36 inch rows averaged 150 seeds per row in a 121 ft. test distance. The planter would plant:
 - a. 21,000 seeds per acre
 - b. 19,000 seeds per acre
 - c. 18,000 seeds per acre
 - d. 17,000 seeds per acre
 - e. 16,000 seeds per acre
28. Penetration of a disk harrow may be increased by:
 - a. raising the hitch point
 - b. lowering the hitch point
 - c. increasing forward speed
 - d. adding shovels
 - e. none of the above
29. A finger-wheel is used on a:
 - a. plate-type planter
 - b. cyclo-planter
 - c. plateless planter
 - d. grain drill
 - e. none of the above
30. Long landsides are used on all plows with:
 - a. depth wheels
 - b. rolling landsides
 - c. furrow wheels
 - d. cover boards
 - e. none of the above
31. A traction assisting control system causes:
 - a. the front of the tractor to lift slightly when draft increases
 - b. the plow to lift slightly when the draft increases
 - c. the plow to operate at varying depths
 - d. all of the above
 - e. none of the above
32. A field cultivator is used as a:
 - a. primary tillage tool
 - b. secondary tillage tool
 - c. soil opener during planting
 - d. listing tool
 - e. all of the above

33. Runner type soil openers are best suited for use in what type of soil?
 - a. trash free hard clay
 - b. rocky loam with trash
 - c. trashy, clay loam
 - d. trash free sandy loam
 - e. none of the above
34. The moldboard acts to:
 - a. cut the trash on the surface of the unplowed land
 - b. cut the vertical furrow wall
 - c. cause the soil to be inverted
 - d. insure a flat furrow bottom
 - e. all of the above
35. A disk harrow pulverizes soil because the:
 - a. forward speed throws the soil
 - b. edges of the blades cut the soil
 - c. curved blade surface causes the soil to crumble
 - d. weight of the blade causes penetration
 - e. none of the above
36. Spike tooth harrows are adjusted for trash clearance and the:
 - a. set of the tool
 - b. spacing between the rows
 - c. depth of penetration
 - d. levelness
 - e. all of the above
37. The center of resistance of a multi-bottom plow is located at:
 - a. $\frac{1}{4}$ the width of cut from the landside
 - b. $\frac{1}{2}$ the width of cut from the landside
 - c. $\frac{1}{3}$ the width of cut from the tip of the moldboard
 - d. two inches from the share
 - e. none of the above
38. The coulter should be located:
 - a. in front of the plow point
 - b. directly over the plow point
 - c. behind the plow point
 - d. placed according to the soil conditions
 - e. none of the above
39. Better penetration of the furrow openers of corn or soybean planters should be obtained by:
 - a. increasing forward speed
 - b. changing the angle of the opener
 - c. adding weight to the planter
 - d. increasing the spring pressure on the openers
 - e. all of the above

40. On a semi-mounted plow the depth is primarily controlled by the:
- a. tail gate
 - b. adjustment of the top link
 - c. gauge wheel
 - d. coulter
 - e. trip block
41. A grain drill can be used to plant:
- a. small grain
 - b. grasses
 - c. soybeans
 - d. clover
 - e. all of the above
42. A disk harrow with notched coulters will penetrate deeper than a similar one with smooth coulters because it will:
- a. turn faster
 - b. turn slower
 - c. have less weight per square inch of cutting edge
 - d. have more weight per square inch of cutting edge
 - e. none of the above
43. As the operating speed of a spring tooth harrow is increased, the harrow teeth will:
- a. vibrate less and be less effective
 - b. straighten out
 - c. change rake angle
 - d. all of the above
 - e. none of the above
44. The seeds are held in the metering mechanism of a cycloplanter by:
- a. air pressure
 - b. partial vacuum
 - c. mechanical fingers
 - d. seed plates
 - e. none of the above
45. A plate-type planter can be adjusted to meter seeds at a different rate by:
- a. changing plates
 - b. changing speed of rotation of the seed plates
 - c. changing the size of the drive wheel
 - d. all of the above
 - e. none of the above

46. To change the alignment of a totally mounted plow:
 - a. rotate the cross shaft
 - b. change the right lifting link length
 - c. change the top link length
 - d. change the depth wheel setting
 - e. reset the bottom
47. The distance between the landsides of two adjacent moldboards is known as the:
 - a. share width
 - b. width of cut
 - c. plowing depth
 - d. capacity
 - e. none of the above
48. Tools used on cultivators will operate at a set depth because:
 - a. suction helps hold them there
 - b. the design of the tool allows it to penetrate to that depth
 - c. the draft on it helps hold it down
 - d. the weight of the cultivator causes it to penetrate
 - e. all of the above
49. The center of resistance of a 6 bottom, 16 inch plow is located:
 - a. 40" to the right of the last landside
 - b. 44" to the right of the last landside
 - c. 48" to the right of the last landside
 - d. 52" to the right of the last landside
 - e. 56" to the right of the last landside
50. Soybeans may be planted by:
 - a. unit planters
 - b. grain drills
 - c. broadcast spreaders
 - d. all of the above
 - e. none of the above
51. When preparing seed beds, the soil is worked to:
 - a. provide large air spaces
 - b. cool the soil
 - c. leave a very rough, uneven surface
 - d. encourage water retention to maintain a very damp condition
 - e. none of the above
52. An increase in draft can be caused by:
 - a. worn plow points
 - b. improper adjustment
 - c. increased speed of operation
 - d. all of the above
 - e. none of the above

53. Rotary hoes are used to:
- thin crops
 - remove weeds
 - break up a crust
 - all of the above
 - none of the above
54. If the right hand lifting link on an integral plow is too short, it will cause:
- the front of the tractor to pull to the right
 - the front of the tractor to pull to the left
 - excessive pressure on the furrow wall
 - the plow to go deeper
 - no change
55. When working the soil after plowing, which implement is best for rocky soil?
- field cultivator
 - rotary hoe
 - disk harrow
 - springtooth harrow
 - cultipacker
56. A disk harrow is used to:
- cultivate row crops
 - do primary tillage
 - prepare a seed bed
 - list the land
 - all of the above
57. The reel of a small grain combine should be adjusted to:
- turn 4 revolutions per minute
 - 3 inches above the cutter bar
 - 18 inches in front of the cutter bar
 - strike the stalks directly on the grain heads
 - none of the above
58. The droplet size of liquids released from sprayers is:
- changed with a change in pressure
 - increased with an increase in pressure
 - controlled by the pump capacity
 - determined by the height of the boom
59. Corn silage is made by:
- removing the ears of corn from the stalks, shelling it and storing the grain at high moisture levels
 - cutting the corn stalk, allowing it to wilt and then storing it in a barn
 - cutting the corn stalk and baling it
 - chopping the corn plant and storing it anaerobically
 - none of the above

60. Forage harvesters may be:
 - a. tractor drawn
 - b. self-propelled
 - c. trailing
 - d. mounted
 - e. all of the above
61. Threshed grain is separated from the straw by:
 - a. the beater only
 - b. the straw rack only
 - c. the cylinder and concave only
 - d. the straw rack and the straw chopper
 - e. the cylinder and concaves through the straw chopper
62. The fan of a combine blows air to:
 - a. convey the grain to the tank
 - b. feed the cut grain into the cylinder
 - c. clean the threshed grain
 - d. clean the cylinders
 - e. carry the straw through the straw chopper
63. Small grain harvesters thresh the grain at:
 - a. the reel and cutter bar
 - b. the riddle
 - c. the cylinder and concaves
 - d. the beater
 - e. the straw rack
64. Granular fertilizer may be applied to a field
 - a. all over the surface
 - b. in strips on the surface
 - c. in narrow bands under the surface
 - d. incorporated into the soil in strips
 - e. all of the above
65. Fertilizers used in agriculture are available as:
 - a. solids
 - b. liquids
 - c. gases
 - d. a and b
 - e. all of the above
66. Which of the following factors affects how wide a swath a centrifugal-type fertilizer spreader will cover in one pass?
 - a. shape of the particles
 - b. size of the particles
 - c. density of the particles
 - d. speed of rotation of the turning disc
 - e. all of the above

67. Forage harvesters may cut the forage into small size by:
- a. reciprocating knives
 - b. reel type knives
 - c. radial type knives
 - d. swinging type knives
 - e. b, c and d only
68. Rotary mowers are used to cut:
- a. weeds
 - b. silage
 - c. small grain
 - d. hay
 - e. b and d only
69. A windrower can be used to:
- a. rake hay into a narrow strip only
 - b. cut hay and put it into a narrow strip
 - c. cut and condition hay only
 - d. cut and condition hay and put it in a narrow strip
 - e. b and d only
70. Forage that is cut, chopped and fed directly to live-stock is called:
- a. silage
 - b. green chop
 - c. haylage
 - d. hay
 - e. low moisture feed
71. When chopping a forage in the field, the operator can change the placement of the cut material in the wagon by:
- a. changing the fan speed
 - b. change forward speed
 - c. change the angle of the discharge chute deflector
 - d. change the speed of the elevator
 - e. a or d
72. A straw walker is used to:
- a. feed material into the bale chamber
 - b. move material out of a combine
 - c. remove the husks from the ears of corn
 - d. separate grain from the straw
 - e. b and d

73. The cutter bar should be adjusted when harvesting soybeans
- 3 inches above ground level
 - to $1/2$ the speed as for corn
 - to twice as fast as for wheat
 - as close to the ground as possible
 - 8 inches above ground
74. Chemicals that are used as pesticides are:
- solids
 - liquids
 - gases
 - all of the above
 - a and b
75. A field distributor applies agricultural chemicals by:
- spraying it on growing plants
 - metering it onto the soil in narrow bands
 - placing it under the soil surface
 - throwing it onto the soil over a wide band
 - all of the above
76. The kind of heads used on a forage chopper may be:
- cutter bar, rotary blade
 - cutter bar, windrower
 - windrow pick-up, row crop
 - cutter bar, row crop
 - c and d
77. The gathering chains on a corn picker act to:
- hold stalks while they are cut
 - move the snapped ears onto the husking bed
 - convey the chopped cobs out of the machine
 - feed the stalks into the machine cut end first
 - move the stalks into the machines top first
78. When the ground behind a working combine is checked, grains of loose wheat are found mixed with straw. This loss is:
- shatter loss
 - cutter bar loss
 - cylinder loss
 - beater loss
 - separating loss
79. The reel of a grain combine should be adjusted to turn:
- $1/2$ times the forward speed
 - $1/2$ to 1 times forward speed
 - $1-1/4$ to $1-1/2$ times forward speed
 - $1-1/2$ to 2 times forward speed
 - 4 times forward speed

80. Chemical applicators that apply dust, usually use what type metering?
- a. star wheel
 - b. variable oriface
 - c. centrifugal separator
 - d. drag finger
 - e. a and d
81. A forage harvester with a row crop header uses what means of separating the stalk of the plant from the root?
- a. a double twist
 - b. a reciprocating mower
 - c. a rotary mower
 - d. a beater
 - e. c or d
82. A jet agitator is found
- a. on a combine in the seives
 - b. in a forage wagon for unloading purposes
 - c. on a plane with a gun demanding to go to Cuba
 - d. in the chemical tank of a sprayer
 - e. in the bale chamber
83. The metering mechanism of the fertilizer part of a grain drill is usually:
- a. internal run
 - b. star wheel
 - c. centrifugal spinner
 - d. variable oriface
 - e. b or d
84. A combine used to harvest soybeans has the function of:
- a. cutting and feeding
 - b. storing
 - c. cleaning
 - d. threshing
 - e. all of the above
85. Wheat should be harvested by a combine at:
- a. above 35% moisture level, W.B.
 - b. 30-35% moisture level, W.B.
 - c. 25% moisture level, W.B.
 - d. 20% moisture level, W.B.
 - e. 10% moisture level, W.B.

86. Which are types of cylinder and concave designs?
- a. rasp bar
 - b. rub bar
 - c. spike tooth
 - d. all of the above
 - e. all except c
87. Large round hay rolls weigh:
- a. 2000 to 2400 lbs.
 - b. 1700 to 2000 lbs.
 - c. 1200 to 1800 lbs.
 - d. 900 to 1100 lbs.
 - e. 150 to 300 lbs.
88. An oblique head hay rake:
- a. has 5 wheels with finger tines
 - b. has provisions for raking the hay perpendicular to the direction of travel
 - c. moves the hay 45 degrees to the direction of travel
 - d. makes the hay into a dense bale
 - e. must be used with a tractor having a PTO system
89. When excessive amounts of cracked grain are present in the grain tank:
- a. open the fan setting
 - b. slow down the seives
 - c. change the beater speed
 - d. lower the cutter bar
 - e. increase the cylinder clearance
90. The pump used on a farm sprayer may be a:
- a. nonpositive displacement
 - b. positive displacement
 - c. high pressure
 - d. roller type
 - e. all of the above
91. Which of the following are necessary to know when calibrating a farm sprayer?
- a. height of boom above the surface
 - b. forward speed
 - c. desired application rate per acre
 - d. distance between nozzles
 - e. all of the above
92. Soybeans should be harvested:
- a. at moisture levels above 27%
 - b. at moisture levels above 20% and less than 27%
 - c. when the moisture first drops below 17%
 - d. when the moisture first drops below 13%
 - e. at moisture levels of 9-11%

93. Chopped forage may be placed into a trailing wagon by:
- a. carried on an air stream
 - b. moved by an auger
 - c. thrown by the cutting mechanism
 - d. conveyed by a bucket elevator
 - e. a and c only
94. Factors that cause high power requirements by a forage chopper include:
- a. kind of cutter mechanism
 - b. kind of header
 - c. design of the feed rolls
 - d. dullness of knives
 - e. each of the above
95. For total coverage of the field surface, even spray nozzle tips should be spaced to give:
- a. no overlap
 - b. 1/8 width overlap
 - c. 1/4 width overlap
 - d. 1/2 width overlap
 - e. between b and c
96. A dry boom is one that:
- a. is limited to one section
 - b. carries the spray material to the nozzle through the pipe that is the boom
 - c. applies a powder or dust
 - d. carries spray material to nozzles through hoses along the outside of the boom
 - e. none of the above
97. A herbicide that is required to be effective for a period of weeks is best applied as:
- a. a liquid form
 - b. a granular form
 - c. a powder form
 - d. a gaseous form
 - e. all of the above
98. Hay is usually baled at what moisture content?
- a. 50%
 - b. 40%
 - c. 35%
 - d. 30%
 - e. none of the above
99. In order to increase the chopped length of corn silage:
- a. slow down the feed rolls
 - b. remove some cutting knives
 - c. add a recutting screen
 - d. all of the above
 - e. a and b

100. If liquid herbicides must be applied in windy conditions:
- a. use low pressure
 - b. use flooding tips
 - c. use low boom position
 - d. all of the above
 - e. b only
101. A spinner type fertilizer applicator applies fertilizer by:
- a. spraying it in a band on the soil surface
 - b. dispensing it through a soil opener below the soil surface
 - c. spreading it on the soil surface over a wide area
 - d. dropping it in a narrow band on the soil surface
 - e. all of the above
102. A hay mower conditioner
- a. cuts, crushes and compacts
 - b. crushes, compacts and windrows
 - c. cuts, crimps, windrows
 - d. cuts, rakes and bales
 - e. chops and rolls
103. A reciprocating mower does not have:
- a. knife sections
 - b. guards
 - c. ledger plates
 - d. shear bar
 - e. knife bar
104. Agricultural chemicals may be used to:
- a. control insects
 - b. increase fertility levels
 - c. defoliate agricultural crops
 - d. eliminate tillage
 - e. all of the above
105. Which of the following factors affect the potential profits expected from using a combine to harvest corn?
- a. operating costs per hour
 - b. field capacity
 - c. material efficiency
 - d. all of the above
 - e. all except c

106. The maximum allowable variation in the amount of output between the nozzles of agricultural field sprayers is:
- a. 2%
 - b. 4%
 - c. 6%
 - d. 8%
 - e. 10%
107. What effect would it have on the amount of acid per acre if the spray material used was at a concentration of 3 times instead of 2 times and the machine was not recalibrated?
- a. no change
 - b. increase per acre
 - c. decrease per acre
 - d. dependent on the ratio of water
 - e. dependent on the pump capacity
108. When checked during calibration, an auger type applicator delivered 75 pounds of fertilizer per acre too much. To correct the machine:
- a. close the nozzles
 - b. use a drive gear with more teeth
 - c. use a drive gear with less teeth
 - d. change the angle of the spinner blades
 - e. b and d

APPENDIX E

APPENDIX E

Examples of Supplementary Material for Module on Plows

Determining the Center of Load on Moldboard Plows

Example 1. Find the center of load on a single bottom moldboard plow that has a width of cut of 12 inches.

The center of load is $1/4$ the width of cut to the right of the landside.

$$1/4 \times 12" = 3"$$

Problem 1. Find the center of load of a single bottom moldboard plow that has a width of cut of 16 inches.

Example 2. Find the center of resistance of a 3-bottom moldboard plow that has a width of cut of 16 inches per bottom.

The total width of cut equals $3 \times 16" = 48"$

The center of resistance for each bottom: $1/4 \times 16" = 4"$ to the right of each landside.

The distance between the center of resistance of the first bottom and the third bottom is: $2 \times 16" = 32"$.

The center of resistance for the total plow will be the average of the distance between center of resistance for the first bottom and the center of resistance for the last bottom. Thus: $32"$ divided by $2 = 16"$. This will place the center of resistance for the plow $16"$ to the right

of the center of resistance for the last bottom. Since the center of resistance for the last bottom is one-fourth the width of the bottom to the right from its landside this will be $1/4 \times 16" = 4"$ plus $16" = 20"$ to the right of the last landside.

Problem 2. Find the center of resistance of a 5 bottom, 14 inch moldboard plow.

Problem 3. Find the center of resistance of a 4 bottom, 18 inch moldboard plow.

Problem 4. Find the center of resistance of a 9 bottom, 16 inch moldboard plow.

Examples of Supplementary Material for Module on Planters

Chart for Field Checks of Plant Population

To check the plant population, measure off the number of feet in a 100th of an acre for the desired row width. (See Chart 1 below.) Then, count the plants (or seeds if simulating planting on a road for calibration), in that designated length of row and multiply by 100.

Example: If you are using 30 inch row spacings, measure 174 feet of row length. If you count 224 kernels, or plants, in that distance, you will have a planting rate (or stand of plants) of 22,400 seeds. ($224 \times 100 = 22,400$)

Chart 1.

<u>Row Spacing</u>	<u>Length of Row to Equal 1/100 Acre</u>
40"	131'
38"	138'
36"	145'
34"	154'
32"	163'
30"	174'
28"	187'

Chart 2.

Plant Population Per Acre (x 1000)

<u>Spacing Within the Row (inches)</u>	<u>Spacing Between Rows (inches)</u>			
	<u>30"</u>	<u>36"</u>	<u>38"</u>	<u>40"</u>
6.0	34.8	29.1	27.5	26.1
6.5	32.1	26.9	25.4	24.1
7.0	29.9	24.9	23.6	22.4
7.5	27.8	23.3	22.0	20.9
8.0	26.1	21.8	20.6	19.6
8.5	24.6	20.5	19.4	18.4
9.0	23.2	19.4	18.3	17.4
9.5	22.0	18.4	17.4	16.5
10.0	20.9	17.4	16.5	15.7

Example of Supplementary Material for
Module on Chemical Applicators

Sprayer Calibration

Short Method of Calibration:

1. Adjust travel speed and pressure and use the type and size of nozzle that will give the best pattern of distribution and rate of application for the particular job. Follow the recommendations of the sprayer and chemical manufacturer. If nozzle tips are worn or corroded, check each nozzle for uniform rate and pattern

of discharge. The rate may be checked by placing quart cups under all nozzles of the same type and size and operating the sprayer. All cups should be filled at the same rate.

2. Measure a course 163 1/2 feet long in the field to be treated.
3. Fill sprayer tank with clean water.
4. Spray the course, maintaining a constant nozzle pressure and travel speed and catching the discharge from all nozzles spraying on one row. Note pressure, throttle, and gear setting, and use these same settings for spraying.
5. Measure discharge obtained in step 4 with a standard measuring cup.
6. Rate of application (gals./acre) = $\frac{\text{Number of cups} \times 200}{\text{Row spacings in inches}}$
to make a spray solution, add the recommended amount of chemical per acre to the amount of water applied per acre. For a 55 gallon drum in vertical position, each inch of depth represents about 1.7 gallons.

Examples of Supplementary Materials for Module on Combines

Determining Corn Harvest Losses

Part A. Determining Ear Loss:

1. Stop the combine in an area of the field that is typical of the crop conditions for the harvest operations.

2. Use the accompanying chart to determine how much row length is required to give a test area of 1/100th of an acre. It is based on the number of rows being harvested at once, and the spacing between the rows.
3. Measure the required length of the rows for the sample area behind the combine. I.e., 4 rows at 30 inch row spacing requires an area 43.6 feet long and 10 feet wide (4 rows at 30" = 120" = 10 feet).
4. Pick up all loose ears or partial ears of corn in the sample area.
5. Each 3/4 pound ear (or equivalent in broken pieces) equals one bushel of corn per acre. Three 1/2 pound ears or equivalent equals 2 bushels per acre.
6. Determine the total loss in bushels per acre.
7. Repeat the procedure in front of the combine to determine the pre-harvest loss. (Use the same sample area in the unharvested rows in front of the combine.)
8. Subtract the pre-harvest loss from the total loss behind the combine to determine the machine ear loss in bushels per acre.

Chart 1. Length of Rows Required for 1/100 Acre (in feet)

<u>Row Spacing (inches)</u>	<u>1 Row</u>	<u>2 Rows</u>	<u>3 Rows</u>	<u>4 Rows</u>	<u>6 Rows</u>	<u>8 Rows</u>
20	262	131	87.3	65.5	43.6	32.7
28	187	93.5	61.3	46.7	31.1	
30	174	87	58	43.6	29	
36	145	72.5	48.3	36.2		
38	138	69	46	34.5		
40	131	65.5	43.6	32.7		
42	124	62	41.3	31		

**Part B. Determining Loose Kernel
Loss and Cylinder Loss**

1. Use a frame of the dimensions given in the accompanying chart (Chart 2) to measure a 10 square foot area along each row behind the combine being harvested in one pass.

2. Lay the frame over one row at a time (parallel to the length of the row).
3. Count all loose kernels of corn within the area of the frame for each row. Two kernels per square foot (20 kernels per 10 square feet) represents a loss of 1 bushel per acre.
4. Move the frame to each row and determine the average loose kernel loss for the machine per acre. I.e., Total for all rows (total bushels) divided by number of rows equals bushels/acre loss.
5. Count the kernels of corn still attached to the cob, or pieces of cob, in each 10 square foot area.
6. Determine the total cylinder loss by dividing the number of kernels per 10 square foot by 20 to get cylinder loss in bushels per acre.
7. Measure the cylinder loss for each row and find the average cylinder loss per acre by taking the total cylinder loss measured for all rows and divide by the number of rows.
8. If the average loose kernel loss is less than 1 bushel per acre, it is considered minimum and no further checks are necessary. If the average loose kernel loss is more than 1 bushel per acre, determine the snapping roll loss.

Chart 2. Dimensions of Frame to Cover Ten Square Feet of Area

<u>Row Width (inches)</u>	<u>Width of Frame (inches)</u>	<u>Length of Frame (inches)</u>
20	20	72
28	28	51.5
30	30	48
36	36	40
38	38	38
40	40	36

Part C. Determining Snapping Roll Loss

1. Back the combine up enough to uncover the area that has been harvested but has not had any discharge from the rear of the combine on it.

2. Use the 10 square foot frame on each row being harvested at once.
3. Determine the loose kernel loss for each row. This represents the loose kernel loss due to the snapping rolls. (snapping roll loss)
4. Subtract the snapping roll loss from the loose kernel loss for the combine to determine the separation loss for the combine.

Part D. Check the Actual Losses
with the Ideal Losses

Machine Ear Loss = ____ Bu. - Should be 0 to 1.0 Bu.
per acre

Loose Kernel Loss = ____ Bu. - Should be 0.4 to 1.0 Bu.
per acre

Snapping Roll Loss = ____ Bu. - Should be 0.2 to 0.5 Bu.
per acre

Separation Loss = ____ Bu. - Should be 0.2 to 0.5 Bu.
per acre

Cylinder Loss = ____ Bu. - Should be 0.2 to 0.5 Bu.
per acre

Total Loss = ____ Bu. - Should be 0.6 to 2.5 Bu.
per acre

Adjustments should be made if losses exceed the expected limits.

APPENDIX F

APPENDIX F

Laboratory Exercises on Hitches and Hitching

Part A. Model of hydraulic lift system

Directions: Use the model of the lift system from a typical tractor and perform the following exercise. Answer the questions in the blanks provided.

1. Turn the pump switch to on.
2. Set the response to slow.
3. Set draft to mid-position.
4. Increase the load with the load lever to simulate an increase in draft on the plow.
5. What do the lift arms do? _____
6. How fast do they respond? _____
7. What direction do they move? _____
8. Decrease the load to its original position.
9. Set the response to fast.
10. Increase the load one notch. What happens? _____
11. How fast? _____
12. Increase the load another notch. What happens? _____
13. How fast? _____
14. Decrease the load one notch. What happens? _____

Part B. Ford tractor hitch system

Directions: Identify each of the following components of the tractor and lift system by writing the appropriate letter from the tag on the tractor in the blank beside the component or answer the question with the correct information from the operator's manual. Perform the tasks described.

Exercise 1. No plow on tractor.

1. _____ Lower lift links
2. _____ Rock shaft arms
3. _____ Lift links
4. _____ Top link
5. _____ Drawbar
6. _____ Position control lever(s)
7. _____ Draft control lever(s)
8. _____ PTO shift lever
9. _____ Response time control
10. _____ Diameter of PTO shaft
11. _____ Number of splines on PTO shaft
12. _____ Distance from end of PTO shaft to drawbar hole
13. _____ Height of drawbar above ground
14. _____ Which link is the sensing link
15. _____ What is the PTO speed

Exercise 2. Plow mounted on tractor.

1. Mount the 2-bottom plow on the Ford tractor.
2. Set the position and draft controls to hold the plow about 8" above the floor.
3. Use the shop jack to raise the rear of the plow.
4. What happens? _____
5. Why? _____

Part C. Massey-Ferguson tractor

Directions: Make the appropriate measurements, perform the tasks given or determine from the operator's manual the information asked for and write your answer in the blank beside the question.

1. _____ Distance from end of PTO shaft to drawbar hole
2. _____ Number of splines on PTO shaft
3. _____ Diameter of PTO shaft
4. _____ PTO speed
5. _____ Lower link pin size
6. _____ Top link pin size
7. _____ Which is the sensing link
8. _____ What category is this system
9. Hitch the plow to the tractor.
10. Level the plow side to side.
11. Level the plow front to back.

12. How is the plow leveled when plowing? _____
13. Does this tractor have provisions for weight transfer during plowing? _____

Laboratory Exercises on Tillage Implements

Directions: Answer the following questions by observing the implements provided or by using the operators' manuals for the implements.

Part A. Field Cultivator

1. What is the operating width of this cultivator? _____
2. How many tools are there on this cultivator? _____
3. What should the clearance be between the tools (center to center)? _____
4. Are the tool carriers single or double spring teeth? _____
5. How many bars does this implement have? _____
6. How is the operating depth controlled? _____
7. Is this a mounted, semi-mounted or trailed implement? _____
8. What type of tools does this cultivator have? _____
9. What type of tools does a field cultivator usually have? _____
10. How is the rake angle changed? _____
11. How is pressure put on the tool to help it stay in the soil? _____
12. Could this cultivator be used to work row crops? _____
13. What is the function of this implement? _____

Part B. Row Cultivator

1. How many rows will this cultivate at once? _____
2. What row spacing is it set for now? _____
3. How many tools does it have? _____
4. Are the spring tooth tool carriers (shanks) single or double leaves? _____
5. How can the distance between the tools be changed? _____
6. How can the distance between rows (for different row spacings) be changed? _____
7. What provisions are made for adjusting the tools vertically in relation to the tool bar? _____

8. How can the rake angle be adjusted? _____
 9. What provisions are made to protect the plants from the thrown soil during the first cultivation? _____
 10. How is the operating depth of the tool controlled? _____
 11. What is the function of the coulter on this cultivator? _____
 12. If one side of the cultivator operates deeper than the other side, how can the tool bar be leveled? _____
-

Part D. Disk Harrow

1. Is this a mounted or trailed model? _____
 2. What is the width of cut? _____
 3. Can this harrow be adjusted to a different cutting angle? _____
 4. How many gangs does this harrow have? _____
 5. How many blades are there per gang? _____
 6. What is the difference between the blades? _____
 7. What is the diameter of the blades? _____
 8. Why are the blades on the front gangs facing outward and those on the rear gangs facing inward? _____
 9. How are the back set of gangs adjusted to give level operation? _____
 10. How is the depth of operation controlled? _____
-

Directions: Write the identifying letter from the tags on the plow components in the blank beside the correct name or write the answer in the blank provided.

Part E. Moldboard Plow (International Harvester)

Exercise 1. Rolling Coulter

1. _____ Coulter yoke
 2. _____ Coulter shank clamp
 3. _____ Coulter shank
 4. _____ Set collar
 5. _____ Cushion spring lock nut
 6. _____ Rolling coulter
 7. How is the coulter kept from swinging completely around? _____
-

8. How is the down pressure on the coulter increased? _____
9. How is the distance between the landside and the coulter changed? _____
10. How is the angle of the coulter swing limited? _____
11. When would you increase the distance between the coulter and the landside? _____
12. Why is the coulter shank made like a crank? _____

Exercise 2. Plow bottom

1. _____ Moldboard
2. _____ Share
3. _____ Shin
4. _____ Landside
5. _____ Landside wear pad
6. _____ Eccentric block
7. _____ How many plow bolts
8. _____ Adjustable pitch bolt
9. How will reversing the adjusting bolt to utilize the thick side influence the tripping load? _____
10. How is the heel clearance adjusted? _____

Part F. Moldboard plow (Ford)

1. What is the width of cut of this plow? _____
2. Are both landsides the same length? _____
3. What kind of trip mechanism does this plow have on each bottom? _____
4. What happens if the crossshaft (part A) is rotated slightly? _____
5. How can the adjustment be made? _____
6. How is this plow leveled, side to side? _____
7. How is this plow leveled front to back? _____
8. What is the function of the triangular shaped piece located behind the trash coverboard (part B)? _____
9. How is heel clearance adjusted? _____

Laboratory Exercises on Planters

Directions: Answer the true-false questions by writing the word true or false in the blank beside each statement. Write the appropriate letter from the tag on the equipment to identify the various components from the planters. Answer all other questions in the blanks provided. Use the equipment in the lab or the operator's manuals.

Part A. International Harvester Cyclo-Planter

1. True-False Questions

1. _____ This planter must have seed corn which is selected by size, such as medium flats.
2. _____ This planter can plant seed corn only.
3. _____ Innoculation is recommended for use with this planter.
4. _____ The planter has chain lift markers.
5. _____ This planter is set up for liquid fertilizer.
6. _____ This planter is dispensing seed all the time the PTO is running.

2. Identify these parts.

1. _____ Serial number
2. _____ Model number
3. _____ Seed drum
4. _____ Seed release wheel
5. _____ Seed manifold
6. _____ Blower
7. _____ Adjustable damper
8. _____ Pressure gauge
9. _____ Pressure gauge reads in what units?
10. _____ Seed hopper
11. _____ Seed cut-off brush
12. _____ Drum rotation indicator
13. _____ Seed delivery tube
14. _____ Seed delivery tube plug-up indicator
15. _____ Number of rows on the planter?
16. _____ Number of 30 inch rows possible on this planter?
17. _____ The seed drum rotation is operated by the PTO, true or false?
18. _____ What kind of pressure holds the seed against the drum?
19. _____ Generates the pressure and is powered by the _____?

Part B. John Deere Planter

1. True-False Questions

1. _____ All new John Deere planters are plateless.
2. _____ The plateless planter requires graded seed.
3. _____ The John Deere planter is equipped so that hydraulic power raises the markers.
4. _____ Soybeans can be planted with the plateless planter.
5. _____ Fluted coulters may be used with this planter.

2. Identification and Questions

1. _____ Planting depth adjustment
2. _____ Feed cup
3. _____ Finger holder
4. _____ Face plate
5. _____ Finger wheel
6. _____ Seed wheel
7. _____ Circumference of the wheel
8. _____ Number of teeth on sprockets on drive wheel
9. _____ Number of teeth on sprockets on cross shaft
10. Assume we are using the setting where the chain is on the 9 tooth driven sprocket and the 11 tooth drive sprocket. Now go to the stand-mounted planter unit and determine the number of kernels of corn which are dropped for 20 revolutions of the hand operated cross shaft.
_____ kernels of corn were dropped.
11. _____ What is the drilling distance covered?
12. _____ What is the row spacing?
13. _____ What would be the plant population per acre?
14. _____ What is the weight of 100 kernels of corn?
15. _____ How many kernels per 50 pound bag?
16. _____ How many kernels per bushel?
17. _____ How many acres will one bushel plant?

Part C. John Deere Grain Drill

1. Identification

1. _____ Seeding rate table
2. _____ Grain box
3. _____ Fertilizer box
4. _____ Grass seed box and rate chart
5. _____ Grain feed shaft

- 6. _____ Grain feed shaft shifter and indicator
- 7. _____ Grain feed gate
- 8. _____ Fertilizer index lever
- 9. _____ Grass seed index lever
- 10. _____ Furrow opener
- 11. _____ Pressure rod and spring
- 12. _____ Grain tube
- 13. _____ Hydraulic remote cylinder

2. Operation

- 1. Number of runs _____
- 2. Row spacing _____
- 3. How is the drill leveled? _____
- 4. Move the grain feed shaft shifter to the left.
What does this do? _____
- 5. What importance does the feed gate adjustment
have? _____
- 6. If the grain indicator lever is set on 28, how
many pounds of wheat would be sown per acre? _____
- 7. What are the two ways of controlling the amount
of fertilizer? _____
- 8. What is the function of the helper spring? _____
- 9. How is drilling depth regulated? _____

3. Using your textbook and all the laboratory machinery, identify by number as many of the following as you can find.

- 1. _____ Fluted feed
- 2. _____ Fluted feed seed gate
- 3. _____ Double internal run feed
- 4. _____ Double internal run feed gate
- 5. _____ Internal run feed drive
- 6. _____ Broadcast seeder
- 7. _____ Field distributor
- 8. _____ Auger feed
- 9. _____ Agitator metering device
- 10. _____ Single disc furrow opener
- 11. _____ Double disc furrow opener
- 12. _____ Deep furrow opener
- 13. _____ Runner opener
- 14. _____ Hoe opener
- 15. _____ Packer seeder
- 16. _____ Press wheel drill
- 17. _____ Link chain covering device
- 18. _____ Check planter
- 19. _____ Hilldrop planter
- 20. _____ Rotary valve planter
- 21. _____ Conventional runner
- 22. _____ Stub runner

Laboratory Exercises on Chemical Applicators

Directions: Use the equipment in the laboratory and the operator's manuals to answer the following questions. Write the correct letter, from the tags on the machines, beside the name of the component. Answer the questions in the blanks provided.

Part A. John Deere Planter with fertilizer attachment

1. Identification

1. _____ Fertilizer hopper
2. _____ Insecticide and fertilizer hopper
3. _____ Fertilizer double disk opener
4. _____ Insecticide metering device
5. _____ Fluted rollers
6. _____ Fertilizer drive shaft
7. _____ Fertilizer auger
8. _____ Fertilizer driver sprockets
9. _____ Fertilizer driven sprockets
10. _____ Jam nut
11. _____ Fertilizer double disk opener spring adjustment bolt
12. _____ Insecticide band diffuser
13. _____ Herbicide diffuser
14. _____ Herbicide metering gate
15. _____ Herbicide spout
16. _____ Insecticide spout
17. _____ Herbicide and insecticide drive chain
18. _____ Fertilizer drive chain idler

2. Operation

1. How is the rate of fertilizer application determined? (2 ways) _____
 2. Is the fertilizer placed in contact with the seed? _____
 3. What are the three steps necessary to increase the depth of placement of fertilizer? _____
-

Part B. John Bean sprayer

1. Identification

1. _____ Piston pump
2. _____ Pressure regulator
3. _____ Pressure gauge
4. _____ Wet boom
5. _____ Boom shut off valve
6. _____ Nozzle body

7. _____ Nozzle strainer
8. _____ Nozzle tip
9. _____ Nozzle cap
10. _____ Jet agitator
11. _____ Agitator shaft
12. _____ Spray return line
13. _____ Line strainer
14. _____ Boom selector valve
15. _____ Sprayer hand gun
16. _____ Chemical tank
17. _____ Rating of pump in gallons per minute
18. _____ Maximum operating pressure of pump
19. _____ How many gallons per minute is this
sprayer delivering per nozzle as set up?
20. _____ How many gallons per acre per nozzle?
21. _____ Roller pump
22. _____ Centrifugal pump
23. _____ Gear pump

Part C. John Deere Grain Drill

1. Identification

1. _____ Fertilizer drive shear pin
2. _____ Fertilizer shifter lever
3. _____ Fertilizer slide adjusting gauge
4. _____ Fertilizer feed shaft
5. _____ and _____ sprockets are interchanged to
changed fertilizer drive speed from
medium to fastest speed.
6. _____ Fertilizer hopper
7. _____ Fertilizer clean-out hole
8. _____ What is the capacity of the fertilizer
box (in pounds)?
9. _____ What is the number of revolutions per
acre which the wheels make?

Laboratory Exercises on Grain Harvesting

Directions: Use the equipment in the laboratory and the operator's manuals to identify the following parts. Write the letter from the tags beside the appropriate part name. Answer the questions in the blanks provided by checking the correct answer.

Part A. John Deere Combine

1. Identification

1. _____ Grain tank
2. _____ Grain tank unloading auger

3. _____ Clean grain elevator
4. _____ Tailings elevator
5. _____ Straw deflector
6. _____ Cutter bar
7. _____ Platform auger
8. _____ Retracting feeding fingers
9. _____ Reel
10. _____ Reel bats
11. _____ Reel adjustable tilting arm (for horizontal adjustment)
12. _____ Reel rack (for vertical adjustment)
13. _____ Divider loop
14. _____ Cylinder drive belt
15. _____ Power-controlled reel positioner
16. _____ Platform drive belt
17. _____ Platform drive belt tensioner
18. _____ Straw rack drive belt
19. _____ Straw rack drive belt tensioner
20. _____ Feeding conveyor tensioner
21. _____ Clean grain elevator drive belt tensioner
22. _____ Remote control shifter rod
23. _____ Lifting spring
24. _____ Lift cylinder brackets
25. _____ Straw rack pitman arm
26. _____ Fan screen
27. _____ Cylinder shaft
28. _____ Beater shaft
29. _____ Beater drive belt
30. _____ Cylinder and concave speed adjustment crank
31. _____ Check flap
32. _____ Straw walker
33. _____ Windboard adjusting lever
34. _____ Cylinder and concave clearance adjuster
35. _____ Cylinder and concave clearance scale
36. _____ Grain return auger
37. _____ Grain conveyor
38. _____ Air intake valve adjuster
39. _____ Tail board
40. _____ Chaffer opening adjusting lever
41. _____ Sieve opening adjusting lever
42. _____ Tailing elevator clean out door
43. _____ Clean grain elevator drive belt
44. _____ Tailings elevator drive belt
45. _____ Clean out door (unloading auger)
46. _____ Feeding conveyor
47. _____ Clean grain cross auger drive belt
48. _____ Cylinder
49. _____ Rasp bar
50. _____ Chaffer
51. _____ Sieve
52. _____ Chaffer extension

2. Questions

1. How is the speed of the cylinder adjusted?
☐ a) Changing gears
☐ b) Changing belt pulleys
☐ c) Adjusting pulley diameter
☐ d) None of the above
2. How is the clearance between the cylinder and concave adjusted?
☐ a) Concave moved
☐ b) Cylinder moved
☐ c) Both cylinder and concave moved
☐ d) None of the above
3. How is the reel powered?
☐ a) From the PTO
☐ b) From the ground wheel
☐ c) Free turning
☐ d) None of the above
4. How wide is the cylinder? _____ inches

Part B. New Idea Corn Picker

1. Identification

1. _____ Snapping rolls
2. _____ Gathering chains
3. _____ Husking rolls
4. _____ Fan
5. _____ Trash ejectors
6. _____ Snapped ear elevator
7. _____ Husked ear elevator
8. _____ Snapping roll clearance adjuster
9. _____ Husking roll clearance adjusters

APPENDIX G

APPENDIX G

Summary of Profile Sheet

1. Have you lived on a farm?
 - a. Yes 89.5%
 - b. No 10.5%
2. Do you live on a farm now?
 - a. Yes 81%
 - b. No 19%
3. Number of years living on a farm:
 - a. 0-5 years 23%
 - b. 5-10 years 4%
 - c. 10-15 years 8%
 - d. 15-20 years 60%
 - e. 20-more 4%
4. Kind of farming enterprises:
 - a. Dairy 33%
 - b. Beef 16%
 - c. Corn and/or soybeans mainly 8%
 - d. General farming 25%
 - e. Other 18%
5. Approximate number of acres farmed:
 - a. Less than 100 17%
 - b. 100-200 15%
 - c. 200-400 23%
 - d. 400-600 25%
 - e. More than 600 13%
 - f. No response 7%
6. Kind of equipment you have operated:
 - a. Tractor 97%
 - b. Plow 82%
 - c. Harrows and field cultivators 81%
 - d. Row cultivators 81%
 - e. Sprayers 65%

7. Kinds of equipment you have operated (continued)
 - a. Planters 65%
 - b. Grain drills 62%
 - c. Corn picker 46%
 - d. Combine--small grain or soybeans 45%
 - e. Combine--corn 40%
8. Kinds of equipment you have operated (continued)
 - a. Mowers 83%
 - b. Mower--conditioners 54%
 - c. Hay rake 77%
 - d. Hay baler 74%
 - e. Self-unloading wagon 54%
9. Do you make the operating adjustments to the equipment you operate?
 - a. Yes 79%
 - b. No 18%
 - c. No response 3%
10. Does someone else make the operating adjustments to the equipment you operate?
 - a. Yes 59%
 - b. No 36%
 - c. No response 5%
11. Do you operate equipment owned by your family?
 - a. Yes 85%
 - b. No 12%
 - c. No response 3%
12. Do you own any of the equipment you operate?
 - a. Yes 23%
 - b. No 74%
 - c. No response 3%
13. Does your family (or you) lease any equipment for your farm?
 - a. Yes 13%
 - b. No 82%
 - c. No response 5%
14. Does your family (or you) have any custom work done?
 - a. Yes 44%
 - b. No 51%
 - c. No response 5%
15. Do you do any custom work for other farmers?
 - a. Yes 44%
 - b. No 51%
 - c. No response 5%

16. How much of the equipment on the farm is stored inside?
- | | |
|--------------------------|-----|
| a. All or most | 38% |
| b. Over half | 29% |
| c. 1/4 to 1/2 | 11% |
| d. Very little | 12% |
| e. None | 2% |
| f. No response | 8% |
17. Which of the following equipment do you store inside?
- | | |
|---------------------------------------|-----|
| a. Tractor | 81% |
| b. Planting and fertilizing | 75% |
| c. Tillage | 34% |
| d. Forage harvesting | 54% |
| e. Grain harvesting | 57% |
18. How much of the machinery repairs do you do yourself?
- | | |
|---|-----|
| a. Most of them | 27% |
| b. About half of them | 24% |
| c. Less than half | 19% |
| d. Take to dealers for most repairs | 3% |
| e. Take to dealers for only major repairs | 22% |
| f. No response | 4% |
19. Did you have any vocational agriculture in high school?
- | | |
|--------------------------|-----|
| a. No | 40% |
| b. 1 year | 11% |
| c. 2 years | 13% |
| d. 3 years | 3% |
| e. 4 years | 32% |
| f. No response | 1% |
20. Do the tractors you operate have a roll bar?
- | | |
|---|-----|
| a. None of them | 59% |
| b. All of them | 4% |
| c. Only the newest one | 22% |
| d. Have roll over protection cabs | 9% |
| e. No response | 5% |
21. Horsepower of tractors you operate:
- | | |
|----------------------------|-----|
| a. 35-50 | 55% |
| b. 50-80 | 68% |
| c. 80-95 | 38% |
| d. 95-120 | 44% |
| e. More than 120 | 20% |

- | | | | |
|-----|--|--|-----|
| 22. | Number of tractors being used on the farm: | | |
| a. | 1 | | 5% |
| b. | 2 | | 12% |
| c. | 3 | | 15% |
| d. | 4 | | 22% |
| e. | 5 or more | | 34% |
| f. | No response | | 13% |

APPENDIX H

APPENDIX H

Attitude Assessment: 1975 Class

Place a check mark in the column that shows how you feel about each of the following statements: SA = strongly agree, A = agree, N = neutral, D = disagree, SD = strongly disagree.

	<u>SA</u>	<u>A</u>	<u>N</u>	<u>D</u>	<u>SD</u>
1. I believe farm machinery should be kept under a shelter.	57%	41%	2%		
2. I believe it is important to calibrate any kind of fertilizer applicator before using it.	48%	41%	11%		
3. Roll over protection equipment should be required on all farm tractors.	21%	30%	33%	12%	3%
4. Guards should be required on all exposed moving parts of farm machines.	38%	41%	13%	6%	2%
5. Leasing of farm equipment should be considered as an alternative to buying certain machines.	10%	59%	22%	6%	3%
6. Hiring some work on a custom basis is a good alternative to buying certain machines.	15%	48%	27%	10%	
7. It is more important to expect a profit from an entire machinery system than from each machine involved.	7%	63%	20%	9%	1%

	<u>SA</u>	<u>A</u>	<u>N</u>	<u>D</u>	<u>SD</u>
8. It usually is a waste of time to adjust agricultural machinery for optimum performance.	1%	8%	7%	27%	58%
9. I believe if small tractors can handle a certain load, a larger tractor would be better.	4%	18%	18%	48%	12%
10. I believe a knowledge of the operation and care of machinery is necessary to be a successful farmer.	59%	39%	1%		1%
11. I believe that a good program of preventive maintenance will result in a reduction of repair costs and a minimum of down time.	59%	40%			1%
12. I believe that it is not necessary to read the operators manual before operating a new piece of equipment.	6%	2%	6%	34%	52%
13. I believe there should not be any governmental regulations with regard to the use of agricultural chemicals.	4%	3%	25%	41%	25%
14. I believe that it is necessary to read bulletins, magazines and other publications to keep up with new trends and developments in farming.	44%	47%	7%		2%

APPENDIX I

APPENDIX I

Summary of Comments from SIRS Forms

I. Slide Tapes

I found that the slide tape series was much better than lecture on the material. I strongly hope that they are continued for future students in this program.

I liked the slide tapes a lot better. It was better for note taking. The pictures help out a lot.

I like the idea of looking at slides 'cause I could take notes at my own speed.

Slides were a lot more educating than I thought they would be. They helped quite a bit.

I felt the slide tapes were a very good benefit and learning experience.

I like the slide-tape set method of learning and the post test system.

I liked the slide and tape but I thought that the post tests that we had to take for the slides and tapes were too hard and one sided.

I think the idea of using slides is very good.

Liked slides.

I liked the slide presentations.

Films were good.

I liked the class very much.

Liked slides and tapes, liked the idea of being able to take each test when you want to.

Liked tapes.

Lectures are boring.
Slides are better.

I really enjoyed the tapes and slides and think it should go on in the future.

I learned an incredible amount of information about machinery.

I like the use of slide tapes.

The textbook is too boring, it's easier to listen to slide-tapes.

The slide tapes were really fantastic, especially your photography.

Tape material was good, because it could be viewed again if necessary.

Good use of slide tapes--I learned a lot.

Slide tape OK

I liked the slide tape outfit.

II. Instructor

The teacher is really interesting and does an excellent job.

I enjoyed the class very much and found Mr. Hetzel more than willing to clarify any questions.

Mr. Hetzel did an outstanding job of preparation for this course. The slide tape series was great! They were presented in such a manner that there were no mistakes possible.

III. General

"Very good class"

Pleased with the system of slides and post-tests--I feel it's a valuable learning method.

I really enjoyed this class but you tried to cover too much in the time allowed. I would have liked to learn more on how to actually run the machines instead of telling us how to run them.

Have material that is on the post test either on the slides or test because I found questions that weren't answered in the tape or text.

But get more outfits into the room so more people can do the slide tapes at the same time and give post test after each slide, tape.

I feel this class could have learned a lot more if there was a lecture instead of the slide tapes. The slide tapes were alright but I don't think I learned that much from them.

Use the same terms that most students use in labeling parts of equipment.

Didn't like the second part with the films because I found myself not finding time to come in and see them or when I did everybody else was there and I would have to wait for hours.

Have 2 lectures advanced and regular to cover more relevant subjects and more appropriate for the advanced lecture.

I think you should have at least one lecture a week.

I think that lectures get the point across better than tapes. It's easier to take notes in lecture, and you can go through the material a lot more thoroughly.

You were hardly ever there when I wanted to take tests. I waited over an hour occasionally.

Not very well explained in lab or class, tests were hard to study for. Nice hard final you give without having much on calculating problems.

Homework problems stink.

Get rid of the slides and tapes. It is hard for a person to stay interested to a machine for learning.

Disliked slides.

Slide tapes are no good and quizzes are too hard.

I did not like the slide tape rather than class.

Eliminate the tape slides, boring can't ask questions as arise.

Slides were not as beneficial as a lecture might be.

IV. Laboratory

Labs are OK.

I suggest you have lab assignments, which count points, on calibration. I know I would have learned better that way.

I think I would change the labs because the way that you have it set up only the people that know anything about farm machinery get the answer, the rest just copy off the ones that have the answers.

Do not have so many numbers in lab; that takes so long.

The labs should be better supervised. Everyone was goofing around half the time.

The lab tests were sometimes not very good in their answers.

V. Post-tests and Testing

Being able to take the post-tests at your own speed was also very conducive to learning.

I liked the slide tape sets and the post tests.

On multiple choice tests, use numbers for answers instead of letters.

I like the slide tapes and all of the aboves are all right but the B and C onlys are bad.

The post tests are in one group.

More relative questions on slide type A, B, C, D, E.

No: All of Above, A + B, C + D, None of the Above

I dislike the questions with all of the above or none of the above.

Multiple choice--had a hard time.

I would have liked to see a smaller rush to use the tapes toward the end of term. Maybe if there were regular scheduled post tests, people would get the work done on time.

I think you should have us take the tests at a required time (in class).

Sometimes you weren't there when I wanted to take a test so I think a required test each week would be good.

Slides did not completely prepare for tests.

Grading was hard.

I felt on the small tests that on the answers to some of the questions, where all of the above was too tricky.

I liked the slides and tapes.

The questions on the quizzes were too confusing.

Don't like the tricky multiple choice questions.

Would like the pretests individually.

Found the test rather difficult. Some questions really questionable as to what specifically is asked. All of these, None of these, those parts.

Questions were too round about.

Tests after slide tapes, the tests aren't to the point, too many areas are left wide open, too many variation in answers possible.

Questions on post tests were difficult and tricky.

APPENDIX J

APPENDIX J

Summary of Post-Course Survey

Part 1. Sent to students from both the 1974 and the 1975 classes.

1. I have referred to the textbook or class notes for information in the last 6 months the following number of times.

	<u>None</u>	<u>1</u>	<u>2</u>	<u>3+</u>	<u>5+</u>	<u>10+</u>
1974:	29%	50%		14%	7%	
1975:	5%	21%	26%	11%	26%	11%

2. My skill at determining speed ratios of machine components is:

	<u>Always Accurate</u>	<u>Usually Accurate</u>	<u>Accurate 1/2 Time</u>	<u>Seldom Right</u>	<u>Not Used</u>
1974:	14%	58%	14%	7%	7%
1975:	11%	68%	11%		11%

3. I can hitch my plow(s) to the tractor for optimum performance:

	<u>With Precision</u>	<u>Reasonably Accurate</u>	<u>Occasion- ally</u>	<u>With Help</u>	<u>Not Applicable</u>
1974:	21%	57%	7%	14%	
1975:	32%	58%		5%	5%

4. I can match the implement to the size of tractor available:

	<u>Always</u>	<u>Most of Time</u>	<u>About 1/2 Time</u>	<u>Seldom</u>	<u>Never</u>
1974:	50%	36%	7%	7%	
1975:	37%	58%	5%		

5. I operate the tractor and/or equipment at the correct speed (according to the owner's manual and conditions):

	<u>Always</u>	<u>Most of Time</u>	<u>About 1/2 Time</u>	<u>Seldom</u>
1974:	43%	57%		
1975:	16%	79%		5%

6. I operate the equipment and tractor with shields, guards and other safety equipment in place.

	<u>Always</u>	<u>Most of Time</u>	<u>About 1/2 Time</u>	<u>Seldom</u>	<u>Never</u>	<u>No Response</u>
1974:	21%	57%	7%	7%		7%
1975:	7%	63%	5%	5%		

7. I follow a better preventive maintenance schedule for my tractor and equipment than I did before taking A.E. 058.

	<u>Definitely Yes</u>	<u>Probably</u>	<u>No Change</u>	<u>Less</u>
1974:	7%	36%	57%	
1975:	26%	32%	42%	

8. I spend more time and use more care to adjust the equipment for proper operation than in the past.

	<u>Definitely Yes</u>	<u>Probably</u>	<u>No Change</u>	<u>Less</u>
1974:	35%	35%	28%	
1975:	47%	32%	21%	

9. I feel I get better results now than in the past.

	<u>Definitely Yes</u>	<u>Probably</u>	<u>No Change</u>	<u>Poorer</u>	<u>No Prior Experience</u>
1974:	29%	29%	35%		7%
1975:	47%	32%	21%		

10. I consider the dealership and its service reputation when purchasing new equipment.

	<u>Of Major Importance</u>	<u>Some Importance</u>	<u>Little Importance</u>	<u>Bought On Price Alone</u>	<u>No Experience</u>
1974:	71%	14%	7%		7%
1975:	47%	38%	11%		5%

11. I think about the best layout of my fields and use more care in laying them out for each operation now.

	<u>Always</u>	<u>Most of Time</u>	<u>About 1/2 Time</u>	<u>No Change</u>
1974:	29%	29%	13%	29%
1975:	37%	47%		16%

12. I try to select the gear and throttle setting for best economy of operation of my tractor.

	<u>Always</u>	<u>Most of Time</u>	<u>About 1/2 Time</u>	<u>Occasion-ally</u>	<u>Not Concerned</u>
1974:	43%	36%	21%		
1975:	21%	58%	11%		11%

13. Would you please comment on the overall course and what you liked or disliked about it?

Part II. Sent to students from the 1975 class only.

14. My feelings about the slide tapes used are that they were:

<u>Very Instructive</u>	<u>Fairly Instructive</u>	<u>Not Very Instructive</u>	<u>Not Instructive At All</u>
47%	47%	5%	

15. I viewed each slide tape:

<u>1 Time Only</u>	<u>2 Times</u>	<u>3 Times or More</u>
47%	37%	16%

16. The short quizzes after each slide-tape were:

<u>Great</u>	<u>Okay</u>	<u>Bad</u>	<u>Terrible</u>
21%	74%	5%	

17. The labs were:

63% - A big help in learning
 26% - Fairly good
 11% - Average
 - Poor learning experience
 - A waste of time

18. The stated objectives for each slide-tape:

- 68% - Helped me identify the major points
- 26% - Were vague in their meaning
- 5% - Were of no help in studying
- Not used by me

19. My feelings about viewing the slide-tapes are:

- 100% - I like doing them on my own time
- I would prefer a set time to view them

20. The slide-tapes should be available:

- 53% - In a greater number of copies at one location
- 26% - At other locations for convenience
- 11% - For longer hours at one location
- 11% - No response

21. My feelings about the use of slide-tapes are that:

- 5% - I prefer lectures instead of slide-tapes
- 68% - Slide-tapes and lectures are both needed
- 26% - Slide-tapes and labs are adequate without lectures
- The whole course should be on slide-tapes (without labs)

Indicate your feelings regarding each of the following:

	<u>Increase</u>	<u>Keep the Same</u>	<u>Reduce</u>
22. The length of the slide-tapes	5%	95%	
23. The clarity of the slides	5%	95%	
24. The clarity of the tapes	21%	79%	
25. The number of quiz questions	11%	79%	11%
26. The difficulty of the quiz questions		68%	32%

	<u>Increase</u>	<u>Keep the Same</u>	<u>Reduce</u>
27. The number of lab activities	68%	21%	11%
28. What recommendations would you make for the course?			

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