ABSTRACT

AN INVESTIGATION AND DEVELOPMENT OF A TECHNICAL CURRICULUM FOR TECHNICIAN PREPARATION IN AGRICULTURAL MECHANIZATION FOR IRAN

by Soleiman Zareian

Purpose.--The purpose of this study was to formulate a curriculum, using data and information obtained through a survey and a review of literature, for a two-year post-high school agricultural mechanization technician training program in Iran.

Procedure.--A jury of experts in the area of agricultural power and machinery, consisting of eight technicians from eight major companies manufacturing agricultural machinery, eight teachers teaching two-year post-high school farm equipment service and sales programs, and eight educators engaged in teaching agricultural mechanization at Michigan State University was selected. The members of the jury rated a list of competencies which were developed after the author had analyzed literature appropriate to the field, including research already completed in the area of agricultural power and machinery. The jury members expressed their opinions by rating each of the listed competencies as to how important they thought it was for an agricultural mechanization technician to

possess that competency in dealing with agricultural power and machinery in Iran. A four-point scale of importance was used in rating the list of competencies. The weighted mean was calculated for each item to describe responses by sub-juries and for the total jury, and to establish an index of importance for each item. The competencies rated "important" by over 80 percent of the jury members were considered in constructing the technical curriculum.

Findings.--The findings of the study could be summarized as follows: (1) the qualifications of a technician were identified as to necessary competencies to adjust, service, and maintain all agricultural machinery and equipment in the shop and/or on the field; (2) he should have the ability to perform minor repair jobs for all agricultural machinery; (3) he should be able to make major repairs in some sub-areas such as small engines, which do not require skilled mechanics; (4) he would not be required to overhaul gas engines, diesel engines or harvest machinery; and (5) he should have some background in basic and elementary science, including applied electricity, mechanics, and mathematics. All of the above competencies (except those in number 4) were identified as being essential to the performance of agricultural machinery activities by a technician. Using the data and the findings of the study,

a curriculum for a two-year post-high school agricultural mechanization technician training program in Iran was developed. The curriculum consisted of thirteen courses as follows: (1) applied mathematics; (2) applied electricity; (3) applied mechanics; (4) service shop; (5) small engines; (6) farm tractors; (7) gas engines; (8) diesel engines; (9) planting and tillage equipment; (10) harvesting machinery; (11) hydraulic systems; (12) power testing unit; and (13) seminar.

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Dedicated to my father,
Mohamad Hosain Zareian,
whose unwavering faith in me
sustained and inspired me
through all my student days.

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CHAPTER I

INTRODUCTION TO THE STUDY

Purpose of the Study

The purpose of this study was to develop a curriculum for a 2-year technician training program in agricultural mechanization in Iran. In order to provide an appropriate basis for the development of the curriculum, the scope of the study included the identification of competencies needed by agricultural mechanization technicians in the area of agricultural power and machinery.

The Need and Importance of the Study

The present population of Iran is estimated at about 23.5 million and the growth of population is at 2.2 percent a year. About 17 million of the population live in rural areas and villages. This segment of the population tend some 2.5 million farms and live in more than 50,000 villages.[1]

While the consumption level of food in Iran has improved over the last 15 years, it is estimated that at

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[1]U.S.D.A., The Agriculture of West Asia (United States Department of Agriculture, 1965).

least 30 percent of the population is undernourished, and 60 percent is hungry or malnourished or both. Many improvements have been made in the cities and urban areas, while few improvements have been made in villages and rural areas. The average calorie intake per person per day is about 2,000 compared with 3,000 per day per person in the more highly developed countries. The difference in quality of diet is even more striking. For instance, the intake of animal protein in Iran, in rural areas, is one-fifth of that of the people in more highly developed areas and cities.[2]

Upon examination of food production at the present time and in the future, we see indications that the food supplies in Iran will have to be increased by more than 80 percent merely to sustain the Iran population at its present unsatisfactory level of nutrition. And the production of animal protein will need to be raised by more than 120 percent.[3]

By the year 2,000, when the population of Iran is expected to have increased by 150 percent, it will be necessary to increase the total food supplies to four times the present level, and supplies of animal protein will have to be about six times the present level.[4]

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[2] F.A.O., The Third World Food Survey (United Nations, 1963).

[3] Ibid.

[4] Ibid.

At the present time about one-third of the total arable land in Iran is under cultivation. Efforts are being made to bring the other two-thirds under cultivation through providing more water and improving the condition of the lands. New methods of farming through mechanization of agriculture could increase the efficiency of the farmlands and improve the quality and the quantity of production at lower consumer costs. These efforts along with increasing the supply of less expensive agricultural machinery available to the Iranian farmers would help solve the present and the future problems of hunger.

The Government of Iran has been trying to make it possible for each farmer to use agricultural machinery through establishing agricultural machinery cooperatives and importing more machinery at lower costs. For example, through a five-year contract effective in 1966, the Government of Iran has agreed to buy some 15,000 units (3,000 per year) of wheel type tractors and related equipment. In addition to the above mentioned contract, a plant will be built by 1969 for the assembling of tractors which in a later stage will be transformed into a manufacturing plant with a capacity of 5,000 tractors per year. At present a private assembling factory with a capacity of 400 tractors per year is operating in Iran. Imported tractors and machinery in Iran are numerous.

For instance, from 1961 to 1965 about 12,440 tractors of many different types were imported to Iran.[5]

Investment by farmers in machinery and equipment has been increasing every year. At the same time, the problems of mechanization are also increasing. For example, the operation of a self-propelled grain combine involves many more mechanical problems than does the threshing of grain with a homemade thresher.

The development of farm power and machinery in Iran has increased the need for trained technicians in agricultural mechanization. In order to perform new operations and execute the old ones more efficiently, it will be necessary to provide more specialists and technicians in the field of agricultural power and machinery. For example, the successful and economical use of mechanical equipment in agricultural production requires skilled technicians who cannot only operate such equipment skillfully, but who can also make the necessary adjustments, service and repairs.

Mechanization of Iranian farms has been hampered by a lack of technicians trained to operate and maintain equipment. Thus costs have often been high, because expensive machinery has remained idle for lack of repairs,

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[5]Asian Productivity Organization, "Experts Group Meeting of Agricultural Mechanization," A.P.O., Vol. 1, June 1968.

and excessive wear has resulted from lack of proper maintenance.[6]

In view of the importance of repair and maintenance, it is essential to have trained personnel available for each piece of machinery used.

The Iranian government, machinery distributors, and Iranian manufacturers can contribute much to the training of personnel for agricultural mechanization. This study has attempted to design a new approach in training agricultural mechanization technicians. The results and the conclusions will be introduced to Iranian authorities, through conferences and publications, to be considered as a basic step for improving the mechanization of agriculture in Iran.

Objectives

The major objective of this study was to develop a curriculum for a two-year post-high school agricultural mechanization technician training program in Iran. The specific objectives of this study could be summarized as follows:

1. To determine the competencies in the area of agricultural power and machinery needed by those agricultural mechanization technicians dealing with farm machinery and equipment.

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[6]Nuredin Mohsenin, "Mechanization of Agriculture in Iran" (Unpublished M.S. Thesis, Michigan State University, 1953).

2. To ascertain the degree of importance of each competency as it was rated by respondents.
3. To review the curriculums of agricultural mechanization technician training programs in some American colleges and universities.
4. To formulate a curriculum, using the findings of the study and the information obtained from reviewing the curriculums, for a two-year post-high school agricultural mechanization technician training program in Iran.

Basic Assumptions

Basic assumptions for this study were as follows:

1. Competencies needed by Iranian technicians in the area of agricultural power and machinery in terms of adjusting, servicing, and repairing internal combustion engines, farm tractors, and machinery are the same as those needed by the American technicians in this area.
2. There is need for a two-year post-high school agricultual mechanization technician training program in Iran.
3. Agricultural power and machinery competencies which were given high ratings in this study were examples of competencies which should be considered when planning a curriculum for agricultural mechanization technician training programs.

4. The respondents were considered qualified to indicate how important it is for a technician to possess the competencies necessary to deal with technical agricultural power and machinery problems. (The respondents were chosen on the basis of education and experience in the field of agricultural machinery.)
5. Each of the three sub-juries tended to be homogeneous in terms of knowledge and experience in the area of agricultural mechanization and educational needs of technicians in this area.
6. It is appropriate to provide a training program at a post-high school level on the basis of a two-year curriculum.

Limitations of the Study

The limitations of the study were as follows:

1. This study was limited to the area of agricultural power and machinery which is a particular area in the field of agricultural mechanics (agricultural mechanization).
2. The study was concerned with the "service function" (mechanical competencies); the "managerial function" was not included (see Berkey findings, p. 15).
3. The competencies were limited to those recorded in the questionnaire (list of competencies).
4. Participation in the survey was limited to the technicians of eight major companies manufacturing agricultural machinery and equipment in the United States,

eight teachers of the two-year post-high school agricultural equipment service and sale programs, and the educators who were engaged in teaching agricultural mechanization in the area of power and machinery at Michigan State University.

Definition of Specific Terms

Agricultural Mechanization.[7]--Agricultural mechanization is defined as the art of equipping agriculture with mechanical aids wherever possible for increasing the efficiency in the enterprises.

Agricultural Power and Machinery.[8]--Agricultural power and machinery includes transmission of power, farm motors, tractors and trucks, and agricultural machinery (formerly called farm machinery).

Agricultural Mechanization Technician.--For the purpose of this study the agricultural mechanization technician is defined as one who works at a semi-professional job which requires a well-developed ability to work with instruments, tools, and certain kinds of agricultural machinery.

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[7]Howard F. McColly, "Agricultural Mechanization East Asia," Agricultural Engineering, Vol. 46, No. 1, Jan. 1965.

[8]Lloyd J. Phipps, Handbook on Agricultural Education in Public Schools (Danville, Illinois: The Interstate Printers and Publishers, Inc., 1965).

Ordinarily, he has a two-year post-high school technical education.

Competence.--Competence is here defined as that qualification which enables an individual to deal adequately and appropriately with any particular subject.

Curriculum.--A curriculum may be defined as an integrated group of organized courses of study of appropriate content and duration, arranged in proper sequence, and leading to definitive educational objectives.

CHAPTER II

REVIEW OF RELATED RESEARCH

Introduction

Since the passage of the National Vocational Education Act of 1917, many investigations have been conducted to determine what subject matter should be taught to people enrolled in the courses of vocational agriculture. Several of these studies were related to the broad field of agricultural mechanics.[1]

Due to the voluminous amount of research that has been done in agricultural mechanics, the review was limited to those studies that related directly to the present investigation. Only those studies in agricultural mechanics that met one or both of the following criteria were reviewed:

1. Relating to agricultural machinery instruction.
2. Relating to the principle of curriculum development in technical education.

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[1] Formerly called farm mechanics.

Research Related to Agricultural Machinery Instruction

In 1963 a study was performed by Solstad to determine a basis for a course of study in farm power and machinery in Minnesota.[2]

Information was gathered from 100 Minnesota vocational agriculture farm management service records and from a survey of these 100 farmers who had consecutive records from 1959-1961. Total cost of repairs, income from custom work, total inventory of machinery, and the percent of maintenance jobs done by the operator were considered in this study.

The findings of the Solstad study were: (1) total expenses of farm power and machinery and dollars spent on repairs and upkeep in this area correlated at the five percent level with labor earning; (2) over 75 percent of the farmers did the listed maintenance jobs on tractors and almost 100 percent of them did their own maintenance work on plows and mowers; (3) farmers do not perform maintenance services as often as is recommended by manufacturers; (4) farmers obtain more of their information from

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[2]Arnold K. Solstad, "A Study of the Relationship Between Income of Farmers in the Minnesota Vocational Agriculture Farm Management Service and Their Activities in the Farm Power and Machinery Area with Implication to a Course of Study" (Unpublished Ph.D. Thesis, University of Minnesota, 1963).

dealers than from vocational agriculture teachers in this area; (5) farmers with highest earnings had studied vocational agriculture in high school. It was concluded that all maintenance jobs and most repair jobs should be taught. Minor repair jobs on the tractor and selection of machinery would also have to be included.

Baker developed a study in Alabama to determine a basis for curriculum and course planning. He attempted to provide descriptive evidence for an appraisal of agricultural mechanics instruction in the areas of farm power and machinery, farm structures, and farm electrification for secondary schools and undergraduate teacher education programs in institutiotns of higher education.[3]

He asked the opinions of 220 farm operators, 92 teachers of vocational agriculture, and 7 teacher educators about the selected mechanical and managerial activities and the status of instructional program in the three selected areas of farm mechanics.

Baker concluded that: (1) farm operators were less qualified to perform the recent mechanical and managerial activities; and (2) the teacher training institutions were providing the instruction in the curriculum of

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[3]Richard A. Baker, "A Comprehensive Study of Three Selected Areas of Farm Mechanics as a Basis for Curriculum Construction and Course Planning" (Unpublished Ed.D. Thesis, Oklahoma State University, 1964).

farm mechanics as recommended by the National Teacher Education Committee of Agricultural Engineers and Agricultural Educators.

Halterman conducted a study concerned with the development of a curriculum for the preparation of agricultural engineering technicians.[4] An effort was made to: (1) determine the important characteristics and attributes of the agricultural engineering manpower force of the state; (2) determine the kinds of activities technicians engage in on the jobs and the technical competencies essential for satisfactory job performance; and (3) develop suggested curriculum for use in preparation of agricultural engineering technicians.

The survey was done by using two questionnaires. Technicians were characterized and distinguished by their distinctive abilities, level of occupational competencies and specialized training. They were said to occupy a position between the positions occupied by professional and skilled workers.

According to the findings of this study, 40 percent of the tractor and farm machinery dealers have technicians in their employ. Fifty-four percent of the

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[4]Jerry J. Halterman, "Determination of the Educational Needs of Agricultural Engineering Technicians in Ohio" (Unpublished Ph.D. Thesis, Ohio State University, 1964).

technical workers spend the major part of their times in the area of agricultural power and machinery. General education subject matter areas important to these technicians include communication skills (English composition, speech, and reading), elementary mechanics, technical training, personnel management, electricity, magnetism, safety, and basic agricultural mechanics.

A different technique was used by Berkey to identify the function performed at the retail dealership level of the farm machinery industry, and the importance of activities that should be performed in fulfilling the selected functions of retail sales, and records and accounts.[5]

Information was obtained through a review of literature and assistance from industry and university personnel. The retail sales, and the records and accounts functions were selected for study. An interview instrument was used. The 21 member jury of experts was composed of seven retail dealership managers and seven industry advisors representing full line farm machinery manufacturers; and seven educational experts involved in farm machinery training programs.

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[5]Arthur L. Berkey, "The Importance of Activities Performed in Functions of the Farm Machinery Industry as a Basis for Training Programs" (Unpublished Ph.D. Thesis, Michigan State University, 1967).

Berkey found that retail sales, records and accounts, management, and service were the four functions identified. Seventy-two activities were identified for retail sales, and the records and account functions. It was concluded that the activities identified were essentially those important to the functions and may be useful in developing training programs.

Research Related to the Principles of Curriculum Development

Clary in the findings of his study provided a basis upon which curriculums can be developed for training agricultural technicians. He prepared guidelines which could be used for developing new or upgrading existing programs. By means of a questionnaire, he obtained responses from 25 agricultural education leaders from 25 institutions, and from 16 nationally recognized experts in the field of technical education.[6] Some of his guidelines which received high and significant rankings are as follows:

1. Curriculum content should be primarily occupation-centered.
2. A balance between technical-supporting content and class-laboratory experiences is essential for learning concepts and principles and their application.

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[6]Joseph R. Clary, "Guidelines for the Development of Training Programs for Agricultural Technicians" (Unpublished Ph.D. Thesis, The Ohio State University, 1964).

3. Preliminary drafts of curriculum content should be developed through a study of the present and future job requirements in the occupational fields selected and the allocation of the required knowledge, skills, and understandings to courses of instruction.
4. The depth and scope of mathematics and science must be tailored to occupational needs of those enrolled.
5. The curriculum should be flexible enough to be easily revised as needed in advance of the changing competencies of the technicians.
6. Curriculum content should be planned with advice, counsel and support of the agricultural industry for which the training programs are being developed. Other agricultural education leaders should also be involved.
7. The curriculum for the agricultural technician training programs should be coordinated with the total institution program.

Emerson prepared a suggested procedure for developing curriculums for two-year post-high school technical programs. The procedures are as follows:[7]

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[7]Lynn A. Emerson, Technical Training Beyond High School (Raleigh: Vocational Materials Laboratory, Division of Vocational Education, North Carolina Department of Public Instruction, 1962).

1. Set up the objectives of the curriculums in terms of desired occupational and educational goals. This includes the scope and level of occupational understandings and skills desired, and the scope and level of general education attainment to be sought.
2. Select specific occupations to be included in the job cluster.
3. Analyze the occupations in the job cluster for training content. This analysis should include:
   a. Technical knowledge and understanding, and technical skills needed.
   b. Basic and applied science and mathematics needed.
   c. Manipulative skills required.
4. List the controls which affect the curriculum.
   a. Total permissible length of the program.
   b. Division of the program by terms or semesters.
   c. Type of schedule of the institution-periods per day and week, length of periods, length of school year.
5. Group the selected curriculum content into major component areas.
6. Set up tentative course title designed to cover the content of each major component area.

7. Allocate the selected curriculum content under the appropriate course title.
8. Decide on the type of instruction needed for certain courses (classroom work, laboratory work, shop work, etc.).
9. Determine the tentative length for each course, in terms of total contact hours, outside study required, and total credit hours.
10. Arrange the courses in appropriate instructional order.
11. Allocate the courses into semesters or terms with approximately equal work loads.
12. Work out a tentative time schedule for the curriculum.
13. Revise the courses, sequences, schedule, etc., as may be found necessary.

Summary of Research Reviewed

The changing concept of agricultural mechanics as a phase of vocational agriculture, together with the increased application of engineering to agriculture, has stimulated research and writing in this field.

The review of this research has shown that: (1) a wide variation in the needs for various skills, abilities, etc., exists among the teachers, technicians, farmers, and so forth; (2) there is a need for training

technical worker such as technicians, mechanics, tractor operators to perform the new operations and the old ones more efficiently; (3) the needs for training technicians in the area of agricultural power and machinery has been emphasized more than the other phases of agricultural mechanics; (4) considerable effort has been applied to research by the leaders in agricultural education.

Reviewing these studies left the impression that a fairly accurate way to decide what to teach in agricultural mechanics would be to follow the changes in agricultural mechanization and include into the program training, understanding, skills, and abilities which will be needed most by the farmers and technicians.

It has been, and it is now a constant challenge to keep abreast and if possible, ahead of the changes of the technicians' needs in mechanized agriculture. The review of former research impresses one with the fact that there has been, and there will continue to be, a need for sound research in order to make wise decisions in planning and/or evaluating agricultural mechanics training programs.

CHAPTER III

RESEARCH DESIGN AND PROCEDURE

Introduction

At the present time, a large portion of agricultural machinery in Iran is imported from the United States. As far as operation, service, maintenance, and repair of farm machinery is concerned, it seems that an Iranian technician who performs operation, service, maintenance, and repair of farm machinery and tractors needs to have the same competencies which are required by an American technician performing the same activities in the United States. Berkey stresses this point:

> Retail farm machinery dealership which provide a retail outlet for farm machinery and equipment to farmers; and provide parts, maintenance, and repair service for their service area vary greatly in size, organization, number of employees, and type of service area. However, they serve essentially the same purpose regardless of their diversity. As farm machinery retail dealerships have similar purposes, the function of the dealership, and the activities performed to fulfill these functions, are essentially the same.[1]

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[1]Arthur L. Berkey, "The Importance of Activities Performed in Function of the Farm Machinery Industry as a Basis for Training Programs" (Unpublished Ph.D. Thesis, Michigan State University, 1967), p. 8.

Since one of the objectives of this study was the identification of those mechanical competencies needed by a technician dealing with agricultural machinery and tractors in Iran, as a basis for construction of the adequate curriculum, it seemed reasonable to secure necessary data and information in the United States.

The following steps were used in order to fulfill the objectives of this study:

1. A list of competencies in the area of agricultural power and machinery was developed after reviewing literature and previously conducted research in this area.
2. The list of competencies was revised after discussions with some experts.
3. A jury of experts in the area of agricultural power and machinery was selected. The jury rated the competencies included in the list as to how important they thought it was for a technician to possess those competencies.
4. The rated and completed list of competencies was used as one basis for developing a curriculum for a two-year post-high school agricultural mechanization technician training program in Iran.

Data Gathering Instrument

Developing the List of Competencies

Through reviewing the previous research and other materials, a list of competencies thought to be those that should be performed by agricultural mechanization technicians was developed. The list of competencies was submitted to the experts in agricultural engineering and agricultural education at Michigan State University for additions and deletions. The experts were contacted and appointments scheduled to provide opportunity to discuss and review the list of competencies.

The list of competencies covered two areas: basic science and agricultural mechanization. After revising the list of competencies, the competencies closely related to each other were clustered together by the author. The items in basic science were clustered into one area; and the items in agricultural mechanization were clustered into eight sub-areas as follows:

1. Service shop,
2. Small engines,
3. Internal combustion engines,
4. Farm tractors,
5. Agricultural machinery,
6. Hydraulic systems,

7. Power transmission,

8. Agricultural machinery management.

The lists were again checked and revised a number of times after discussions with some experts in agricultural engineering and agricultural education at Michigan State Univeristy. The process of submitting the list of competencies to the experts for revision continued until no further addition or deletions were suggested. The revised list of competencies consisted of 5 items in the area of general education and 71 items in the area of agricultural mechanization (Table 3, p. 112).

Developing the Rating Scale

Through study of research design references, and consultation with educational researchers, a rating scale was developed. The "four point" rating scale developed was as follows:

3--Important

2--Of some importance

1--Of no importance

0--I don't know

The scale was for the jury of experts to use in rating the importance of the listed items of competencies. The completed instrument was thoroughly rechecked upon the advice of certain experts in education research at Michigan State University.

Method of Selecting Jury of Experts

A jury of experts was selected to rate the list of competencies in order to obtain an opinion as to the importance of competencies included in the list. The jury consisted of three sub-juries: (1) expert technicians in the area of power and machinery; (2) teachers teaching post-high school farm equipment service and sales programs; and (3) educators engaged in teaching agricultural mechanization at Michigan State University.

Selecting Expert Technicians

A letter was sent to personnel directors in each one of the eight major companies manufacturing agricultural machinery and tractors in the United States. They were asked to cooperate in this study and to send the name and the address of one of their outstanding technicians with the following qualifications:

1. Has at least two years of post-high school technical education, but not holding a B.S. degree.
2. Deals with repairing, servicing, and adjusting agricultural machinery.
3. Has at least two years experience in repairing agricultural machinery and tractors.
4. Has at least one year overseas experience in handling agricultural machinery.

Each company introduced one of their technicians to serve as a jury member in this study. The eight major companies which cooperated in this study were as follows:

1. Allis Chalmers Company
2. J. I. Case Company
3. John Deere Company
4. Ford Motor Company
5. International Harvester Company
6. Massey Ferguson, Inc.
7. Minneapolis-Moline
8. Oliver Corporation

Selecting Teachers

According to the Michigan Department of Education there were 23 schools in the United States offering a two-year post-high school farm equipment service and sales curriculum including a placement program. One-third (eight) of these schools were selected at random, and a list of competencies was sent to the coordinator (director) of service and sales program in each selected school. Each teacher possessed the following qualifications:

1. He coordinates the program.
2. He teaches one or more subjects in the area of power and machinery.
3. He has had at least two years experience in teaching agricultural power and machinery in farm equipment sales and service programs at post-high school level.

Selecting Educators

All educators engaged in teaching and research in the area of agricultural mechanization (power and machinery) at Michigan State University with the following characteristics were asked to participate in this study:

1. Faculty member of Michigan State University.
2. Teaching and dealing with agricultural mechanization.
3. Experience in training personnel to serve in agricultural mechanization.

Data Gathering Techniques

The data and information were gathered by using the following procedure:

1. The list of competencies along with a cover letter was mailed to eight technicians whose names and addresses were furnished by personnel in their respective companies. They were asked and instructed to rate the list of competencies based upon their own judgment and experiences as how important they thought it was for a technician to possess those competencies in dealing with farm machinery and tractors in Iran. A stamped, self-addressed envelope was enclosed for their convenience in returning the completed list. Two weeks later, a follow-up letter was mailed to those who

had not returned the completed list by that time. All eight technicians completed and returned the lists of competencies.

2. The list of competencies, along with a cover letter and a stamped, self-addressed envelope for returning the completed list, were mailed to eight teachers teaching post-high school farm equipment service and sales programs whose names were obtained through correspondence with their respective schools. The teachers were asked to respond and instructed how to rate the lists and return them. It was also mentioned, in the cover letter, that the findings and results of this study will be used as a basis for construction of a two-year post-high school curriculum for agricultural mechanization technician training program in Iran. The list of competencies was completed and returned by all eight of the teachers.
3. Personal interviews were conducted to obtain the educators' ratings of the list of competencies. Eight lists of competencies were submitted to eight educators, the purpose of the study was explained by the author, and the educators were then asked to rate the list of competencies based on their own judgment and experience in agricultural mechanization. Each of the educators completed and returned the list of competencies.

Data Treatment

The data collected by the rating procedure were treated in the following manner:

1. To express the opinion of each sub-jury and the total jury regarding the degree of importance of each item of competencies, the means were calculated for each item.
2. Means for each sub-area were calculated in each sub-area for sub-juries and the total jury.
3. The weighted means and the rank order of importance score for the total jury were derived (Table 3, p. 112).

Curriculum Construction

After the statistical treatment of data, the results were analyzed and interpreted by the author to determine the degree of importance of each area, and the findings were used for construction of a two-year post-high school agricultural mechanization technician training program curriculum as applied to Iran.

The competencies which were rated "important" (3 rating points) by over 80 percent of the jury members (2.40 weighted mean) were considered in construction of the curriculum.

In constructing the curriculum, in addition to the findings of the study, some other sources were found to be useful (see the basis for determining course outline).

CHAPTER IV

PRESENTATION AND DISCUSSION OF DATA

Introduction

The data regarding the competencies needed by agricultural mechanization technicians are analyzed and the findings are presented in this chapter. For the purpose of constructing the curriculum, it was necessary and essential to find out how important the jury of experts thought it was for a technician to possess the competencies included in the list.

The jury, which consisted of three sub-juries (technicians, teachers, and educators), rated the list of competencies. The responses received by each sub-jury were analyzed separately and collectively. A weighted mean for each item of competency was calculated for each sub-jury and also for the total jury. The relative importance of a competency was based upon a weighted mean of all responses to that competency.

Rank Order by Items

To calculate the weighted mean of each competency, three points were assigned to each response listed under "important"; two points to "of some importance"; one point to "of

no importance"; and zero to "I don't know." The sum of points for each item was determined and divided by the number of respondents rating that item. Data in Table 3 (see Table 3, p. 112) contains the weighted means for each sub-jury for each item; and the items within each sub-group are arranged in descending rank order according to the weighted means for the total jury. These data indicate that three out of 71 competencies had weighted means of less than two points ("no importance"). Twenty-two of the 71 competencies had weighted means of three points ("important"), which indicated a rating of "important" by all jury members. Ffity-one out of 71 competencies were rated by 85 percent of the jury members as "important." Out of a total of 1704 (i.e., 24 jury members × 71 competencies in the list) ratings the total number of "I don't know (0)" was only 40 (2.3 percent) and the total number of "of no importance (1)" was 160 (9.4 percent), all others (88.3 percent) having been rated at some degree of importance by jury members.

Rank Order by Sub-Areas

Each sub-area of the competencies was examined to determine whether any one competency was considered by the jury to be more important than another for technicians. A weighted mean of the importance rating was calculated for each sub-area and used as a basis for the analysis. The relative importance was the highest for the hydraulic systems and small engines sub-areas and was the lowest for the basic science area. The descending ranks for all sub-areas are shown in Table 1.

Table 1.--Descending Rank of Sub-Areas

Rank Order	Sub-Areas	Weighted Mean
1	Hydraulic Systems (3)*	2.98
2	Small Engines (4)	2.87
3	Internal Combustion Engines (19)	2.84
4	Farm Tractors (8)	2.82
5	Farm Machinery (17)	2.70
6	Service Shop (7)	2.68
7	Power Transmission (4)	2.66
8	Agricultural Machinery Management (4)	2.63
9	Basic Science (5)	2.44

*Number of competencies included in the sub-area.

Comparison of the Sub-Jury Rating

Figure 1 shows the comparison of the weighted mean for each sub-area by each sub-jury and the total jury. Each item, and as a result, each sub-area, received a different rating by each sub-jury. For example, the relative importance of farm tractors, farm machinery, and service shop sub-areas was rated higher and the basic science area and farm machinery management sub-area were rated lower by the technician sub-jury than the other two sub-juries (educators and teachers). This could be interpreted that the technicians sub-jury placed a higher value on the manipulative skills than on knowledge of the subject area in their ratings.

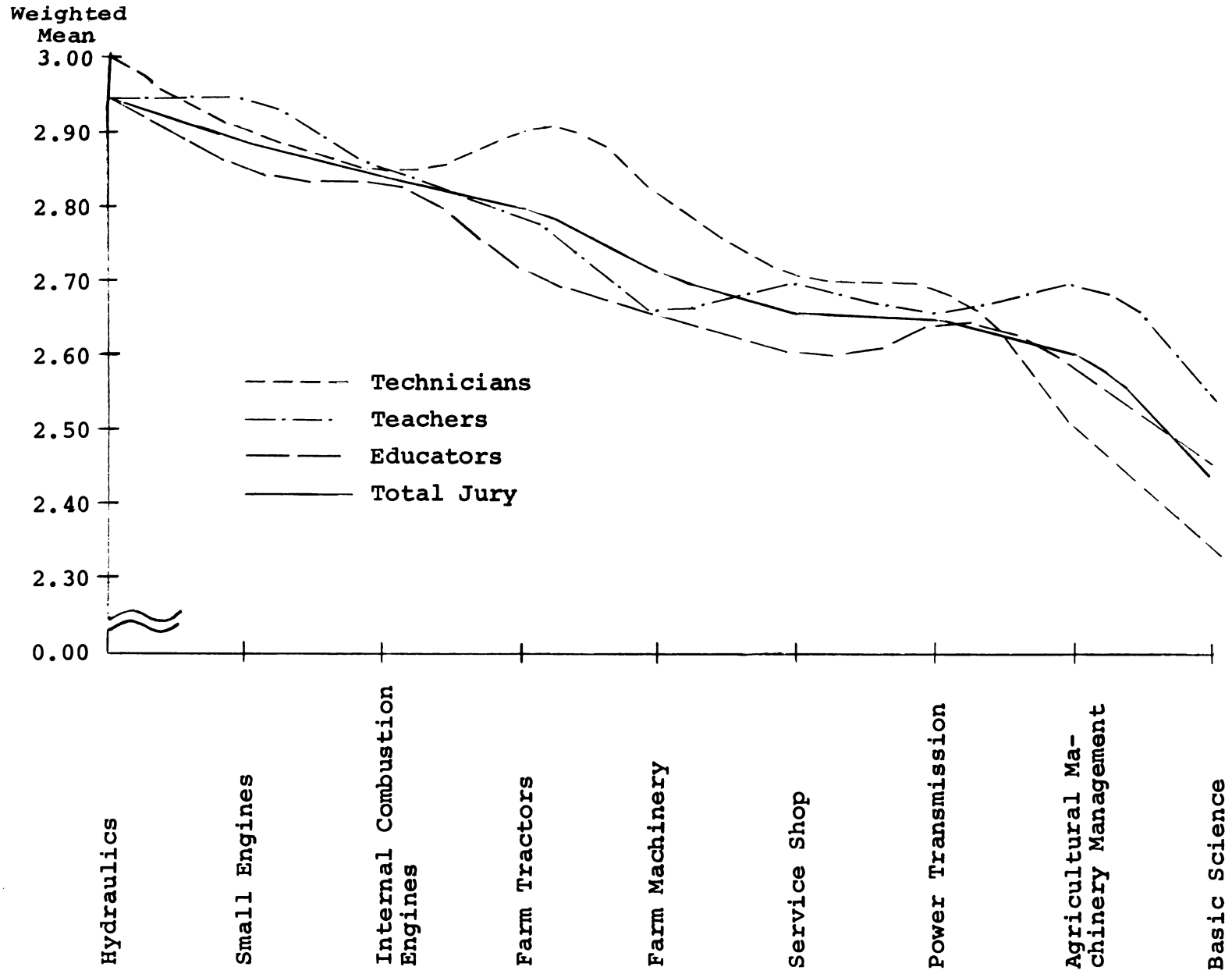

Figure 1. Sub-juries rating comparison for each sub-area. Weighted means of the sub-juries ratings compared for each sub-area of competencies.

Analysis of the data secured from the technicians sub-jury showed that they perceived the technicians' jobs to be that of skilled craftsmen, narrow in nature and scope, with a practical and technical orientation. The educators and the teachers sub-juries looked at the technicians' jobs as semi-professional jobs which require a considerable background of basic knowledge in science and mathematics fields, and which also require a well-developed ability to work with instruments, tools, and certain kinds of machinery.

Interpretation of Data (Findings)

Analysis of data indicated that a technician's job in the area of agricultural mechanization dealing with agricultural power and machinery is technical and practical in nature, rather than theory oriented. The interpretation of data could be summarized as follows:

1. A technician must possess necessary skills and abilities to adjust, service, and maintain all agricultural machinery such as internal combustion engines, farm tractors, tillage and planting equipment, and harvesting machinery in the shop and/or on the field.
2. A technician must be able to perform minor repair jobs on all agricultural equipment as well as major repairs on some machinery such as small engines,

tillage and planting equipment, which do not require skilled mechanics. Overhauling gas and diesel engines and harvesting machinery were not recognized as a job for a technician.

3. Besides the technical skills, a technician needs some basic "know-how" and "know-why" knowledge about all machinery such as farm tractors, agricultural machinery, and internal combustion engines. He must understand the basic fundamentals and the principles of all machinery and equipment handled.
4. Some basic and elementary science including applied mathematics, applied mechanics, and applied electricity are to be included in the program to provide the necessary background for learning related technical areas.
5. In the service shop sub-area, only the competencies which are required in maintenance and repairing agricultural machinery and equipment were indicated as "important." Selection, use, and maintenance of hand tools, arc and oxy-acetylene welding, and micrometer reading were emphasized. Construction of labor-saving devices and jobs of this nature were rated as "no importance."
6. Manipulative skills in repairing and maintenance of small engines were indicated as "important" by

all jury members. The basic fundamentals, parts identification and functions, maintenance, and repairing of gasoline engines are to be covered in the program.

7. In the case of gas engines (gasoline engines) emphasis was upon the principles and diagnosis, service, and repair of farm tractors and engines.
8. The repair of diesel engines, especially fuel injection system, was not recognized as a function to be performed by these technicians. However, the principle of diesel engines and their components, their inspection, service and maintenance, as well as the use of special equipment for testing the engines was recognized to be a job for the technician.
9. In the farm machinery sub-area, most emphasis was placed upon tillage, planting, and harvesting equipment. Data show that these three categories should be taught in the most practical and technical manner.
10. An introductory course in hydraulics should be designed to develop an understanding of the fundamental principles of fluid power. The technical language, principles, systems, and components of hydraulic units, and their applications are to be studied.

11. The review of the data showed that the power transmission sub-area should be taught. (It may be an independent course, but could be taught as a part of the farm tractor course.) All items in the power transmission sub-area which were rated "some importance" or "important" are either a part of tractor system or related to them. For example, gears, differentials, final drives, and pulleys which were rated "important" are also a part of farm tractor systems (see Table 3). In the farm tractor course the components,systems, operation, and control of farm tractors is to be studied. Engine and hydraulic systems are excluded. An understanding and application of the fundamental principles of mechanical systems of power transmission should be stressed with particular emphasis placed on tractor transmissions and final drives.
12. It was indicated that a technician must be able to test, evaluate, and diagnose agricultural machinery, especially internal combustion engines, because he should recognize whether a repair job is a minor or a major one, and whether or not it could be done in the service shop or should be sent to a professioanl mechanic. Knowledge in power testing and diagnosis should be offered in the program. Instruction should include malfunctions and their

interrelationship with other components in electrical and non-electrical systems of farm tractors and engines.

13. In the agricultural machinery management sub-area, determining capacity, performance, custom rate and the proper selection of agricultural machinery were rated high. Therefore, they ought to be considered in the program.

CHAPTER V

CURRICULUM CONSTRUCTION

Introduction

Curriculums in technical education have at least three components around which they should be structured: (1) the training programs should prepare the graduates to take an entry job in which they will be productive; (2) the technical training, together with a reasonable amount of occupational experience should enable the graduates to advance to positions of increasing responsibility; (3) the foundation provided by the training programs should be broad enough so that the graduates can do further study within their field of technology.[1]

The task of developing a curriculum from content obtained from a survey is that of arranging the content into appropriate courses of suitable length and arranging these courses in proper sequence.[2]

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[1]Jerry J. Halterman, "Determination of the Educational Needs of Agricultural Engineering Technicians in Ohio" (Unpublished Ph.D. Thesis, Ohio State Univeristy, 1964).

[2]Lynn A. Emerson, Technical Training Beyond High School (Raleigh: Vocational Materials Laboratory, North Carolina Department of Public Instruction, 1962).

The development of a curriculum for use in a two-year post-high school technical training program to prepare agricultural mechanization technicians in Iran is the main purpose of this chapter.

The objective of the total curriculum recommended in this study is to train a competent agricultural mechanization technician who shall be capable of working with agricultural machinery and equipment, and of performing a satisfactory job for his employer.

Curriculum Outline

Consultation was held with consultants in the Bureau of Education Research, College of Education, Michigan State University, with respect to appropriate treatment of data and the use of data as a basis for construction of a two-year post-high school agricultural mechanization technician. In accordance with recommendations made by personnel of the Bureau of Education Research, items of competencies rated "important" (3 rating points) by over 80 percent of the jury members (over 2.40 weighted mean, see Appendix E) were considered identified as having importance in the performance of the agricultural machinery activities. Therefore, the curriculum which was designed was based on these competencies.

The analysis of data concerning competencies needed by agricultural mechanization technicians and the findings of the study provided important information upon which to base the development of this curriculum.

To determine the curriculum outline, course sequence, time distribution, and the hours spent in classroom and laboratory, the competencies which were identified as needed by agricultural mechanization technicians were considered basic to the course of study. In addition to that, some other sources were used, such as: (1) suggested course outline for the Bay City Farm Implement and Tractor Program;[3] (2) Halterman's findings and recommended curriculum for a two-year post-high school agricultural engineering technicians program in Ohio (see page 13); and (3) a suggested two-year curriculum for agricultural equipment technology by the State University of New York (see page 43).

Iranian students generally do not have a strong background in technical education or extensive orientation to modern agricultural machinery. Therefore, the class and the laboratory periods for each course should be more than is recommended for students in the United States. For example, if two hours of class and four hours of laboratory per week is recommended for a given course in the United States, for teaching the same course in Iran three hours of class and six hours of laboratory per week should be considered (Table 2).

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[3]"A Suggested Course Outline for Training Farm Equipment Mechanics in Bay City," Manpower Training and Development Act, 1964. Bay City Public Schools, Bay City, Michigan.

Table 2.--Curriculum Outline

Semester	Course	Hours Per Week		Hours Per Semester
		Class	Laboratory	
First	Applied Electricity	2	4	108
	Applied Mechanics	2	4	108
	Service Shop	1	4	90
	Seminar	1	0	18
Second	Applied Mathematics	3	0	54
	Small Engines	2	4	108
	Farm Tractors	3	6	162
Third	Gas Engines	3	6	162
	Planting and Tillage Equipment	3	6	162
	Hydraulic Systems	2	2	72
Fourth	Diesel Engines	2	4	108
	Harvesting Equipment	2	4	108
	Power Testing	2	4	108
	Field Trips	0	5	54

Note:

A period of ten weeks during the summer, between the first and second year, would be used for occupational experience in agricultural equipment or related fields (see occupational experience).

The curriculum is based on two academic years or four semesters; each semester is to consist of 18 weeks, therefore the total program is 72 weeks. In addition to 72 weeks of instruction, a period of ten weeks is also considered for the summer job experience (see Table 2).

The Basis for Determining the Course Outline

Figure 1 (page 32) shows a remarkable agreement between three sub-juries regarding the degree of importance for technicians to possess each item of competency, and the items which should be given higher priority and be included in the technician training curriculum. This agreement indicated that the technical educational needs of agricultural mechanization technicians have been recognized, and the members of three sub-juries were aware of skills and abilities required by the technicians for adjusting, servicing, and repairing agricultural machinery and equipment.

To compare the findings of this study with the current agricultural mechanization technician training programs offered by American institutions, the curriculums of agricultural equipment technology, and agricultural equipment service and sales in some colleges and universities (see page 43) were reviewed by the author. Some of these institutions were selected from the eight participating colleges and university, those institutions from which the coordinators of agricultural equipment programs agreed to serve as members of a sub-jury (see Appendix C).

The review of those curriculums revealed similarities between the findings of this study and the agricultural equipment programs in those institutions in regard to the objectives of the programs and the curriculum

content, with the exception that some of those curriculums were prepared for service and managerial functions (see page 15, Berkey findings). However, this study is only concerned with the service function and does not deal with the managerial function (see the limitations of the study).

To determine the course content and outline, the items of the study findings were broken down and analyzed. Along with that, certain other sources were also used in building course outlines, in selecting texts and references, and audiovisual aids. Some of these sources were as follows:

1. "Agricultural Equipment Technology, A Suggested Two Year Curriculum," published by State University of New York with the cooperation of the U.S. Office of Education in 1967.
2. "A Suggested Course Outline for the Bay City Farm Implement and Tractor Program," prepared under the Manpower Training and Development Act in 1964 (see page 40).
3. The current curriculums of agricultural equipment technician training programs in some two-year colleges and universities such as North Iowa Area Community College, Nebraska Vocational Technical College, and Michigan State University.
4. Some previous research in the methodology and principles of curriculum construction (see page 15,

Clary study) as well as approved techniques, guidelines, and procedure of developing curriculum in technical education (see page 16, Emerson).

5. Interviews and consultation with the educators and the experts in the area of agricultural power and machinery at Michigan State University.
6. The author's own experience, which includes seven years of teaching agricultural power and machinery and one year of administration in the Agricultural Training Center in Iran.

Course Outline

The courses presented in Appendix B are intended to suggest the content which might be included in such a program. The materials suggested provide a practical and attainable coverage of the area of agricultural power and machinery in the field of agricultural mechanization.

At the end of each course outline is a list of texts and reference materials. Each should be analyzed for its content and pertinency, and new and more suitable sources should be substituted if they are available. Suggested teaching media are listed for many courses.

It is expected that the experienced instructor will make liberal use of charts, slides, models, samples, and specimens which illustrate special technical aspects of the subjects to be covered.

The laboratory sessions suggested in the curriculum outline and in the course descriptions are not necessarily intended to be a single session, but rather as total hours of laboratory per week, to be scheduled in periods of logical duration.

Although no examinations have been scheduled in the outlines, it is clearly intended that there will be time available for them. The chief value of examinations to the teacher is to find out how effectively he has taught the course and to evaluate the extent to which the students have learned the requisite knowledge and skills. Examinations may stimulate the students to make periodic reviews of the materials presented in the course.

CHAPTER VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

Purpose of the Study

The purpose of the study was to develop a curriculum for a two-year post-high school technician training program in Iran, based on data and information obtained through a survey and the review of literature.

Procedure

Through reviewing related research and literature a list of competencies was developed. The list was revised after discussion with experts. A jury of experts consisting of eight technicians dealing with agricultural power and machinery from eight major companies, eight teachers teaching a two-year post-high school farm equipment service and sales program, and eight educators engaged in teaching agricultural mechanization at Michigan State University was selected. The list of competencies along with a cover letter was mailed to the technicians and the teachers for their rating. They rated the list and returned them by mail.

The educators rated the list of competencies through personal interview.

The twenty-four jury members rated the list of competencies and expressed their opinions as to how important it was for an agricultural mechanization technician to possess each item of the competencies included in the list in dealing with agricultural power and machinery in Iran.

Analysis of Data

The data collected by the rating procedure was treated in the following manner:

1. A mean was calculated for each item to describe responses by sub-juries and for the total jury, and to establish an index of importance for each item.
2. An index of importance score was obtained for competency sub-areas by adding the responses to items in each sub-area by sub-juries and by the total jury and calculating weighted mean scores.
3. The weighted mean for the total jury by item and by sub-area was presented and the rank order of importance score was derived.

Summary of Findings

The findings of the study could be summarized as follows:

1. A technician must possess necessary skills and abilities to adjust, service, and maintain all agricultural machinery and equipment in the shop and/or on the field.
2. Minor repairing jobs for all agricultural machinery was recognized as requirements for technicians to handle.
3. Major repairing in some sub-areas such as small engines and some other jobs which do not require skilled mechanics were emphasized to be performed by the technicians. Overhauling gas engines, diesel engines, and harvesting machinery was not recognized as a job for the technicians.
4. Some basic and elementary science including applied electricity, mechanics, and mathematics should be included in the program.

Curriculum

Those items considered to be of particular importance in the construction of a curriculum for agricultural technicians were the items given top rating ("important") by over 80 percent of the jury members. In addition to those items some other sources such as the

current curriculums of agricultural equipment technology and agricultural technology service and sales were also used (see the basis for determining course outline).

The curriculum consisted of the following courses:

Applied mathematics

Applied electricity

Applied mechanics

Service shop

Small engines

Farm tractors

Gas engines

Diesel engines

Planting and tillage equipment

Harvesting equipment

Hydraulic systems

Power testing unit

Seminar

For each course the number of hours of instruction, laboratory and class activities as well as texts and references were presented. This curriculum was designed for a two-year post-high school agricultural mechanization technician training program in Iran.

Conclusions

Based upon the findings presented in this study, the following conclusions were drawn:

1. General agreements existed among all three sub-groups of jury members regarding competencies needed by agricultural mechanization technicians.
2. Certain competencies were identified as necessary for the satisfactory work performance by agricultural mechanization technicians.
3. The competencies rated as "important" by more than 80 percent of the jury members were those considered necessary to enable technicians to adjust, service, maintain and perform minor repairs on all agricultural machinery and equipment.
4. The jury members indicated that they expected the technicians to be capable of making major

repairs, which do not require skilled mechanics. However, the technician was not expected to overhaul tractors, gasoline and diesel engines, or harvest machinery. He should be able to recognize whether or not a repair job could be done in the service shop or should be sent to a professional mechanic.

5. A technician, in addition to his technical skills, needs some basic knowledge and understanding of the fundamentals and the principles of all machinery and equipment handled.

Recommendations

Recommendations, based on the data gathered for this study as well as other sources reviewed by the author are presented for consideration by those persons responsible for developing training programs in Iran.

Such information may be helpful in providing a basis for the development of technical educational programs to meet the training needs of persons in, or preparing to enter, the agricultural mechanization occupation in Iran.

1. The curriculum designed for this study should be used for the preparation of agricultural mechanization technicians at the post-high school level. This curriculum is especially designed to meet the needs of persons who are or will be working directly with agricultural machinery and equipment.
2. Training programs for agricultural mechanization technicians should be technical and practical in nature rather than theoretically oriented. Therefore facilities should include adequate

workshops, laboratories, and land for student practice with the tractors and farm machinery.

3. In order to become more aware of what occupations exist for technicians and of the job functions associated with each occupation, intensive channels of communication should be developed among the educational institutions, industry, and the agricultural mechanization organizations. Necessary changes should be made in the program to keep it up-to-date and to meet the present and the future needs of the country in terms of trained technicians who can handle agricultural machinery skillfully.
4. When determining the technical educational needs of agricultural mechanization technicians it is appropriate to identify competencies through a survey using technicians who are working directly

with agricultural power and machinery in industry or through retail dealers.

Recommendations for Further Research

In order to improve technical education in the field of agricultural mechanization in Iran, an investigation of the following problems is recommended:

1. Analysis of the needs and the methods of re-educating those technicians who are already employed in agricultural mechanization.
2. Identification of the educational needs of other groups of workers in agricultural mechanization such as tractor drivers, machinery operators and overhaul-mechanics.
3. Development of an overall and country-wide plan for training agricultural mechanization technicians.

4. Development of new programs to prepare qualified teachers for instruction in agricultural mechanization training programs.
5. Study of the procedure and the techniques by which the curriculum designed in this study could be applied and used more efficiently and effectively in Iran in order to get the best possible results. The graduates from this program should have the competencies which are requisite to the operation of a successful agricultural mechanization program.
6. Evaluation of the over-all program. The training program should be carefully evaluated by means of the follow-up process. The purpose of this evaluation is to see if it provides educational opportunities to meet the current and projected

needs of the technicians, and to compare the actual outcomes of the courses with the competencies required by employers.

APPENDICES

APPENDIX A

GENERAL CONSIDERATIONS IN ORGANIZING AGRICULTURAL MECHANIZATION TRAINING PROGRAMS

A-1. Selection of Faculty

To provide meaningful learning experience for the students in technician training program, the teaching staff must be dedicated to this type of instruction. They must have a strong base in, and knowledge of, principles supported by adequate training. They must have a knowledge and thorough understanding of agricultural machinery; its units and components, construction, operation, maintenance and application in systems of agricultural mechanization. Teachers of specialized technical subjects are required to have advance technical training and practical experience. Continuing education and membership in professional and technical organization is recommended to keep teachers abreast of current findings and research in agricultural mechanization.

A minimum of three to four full-time faculty members are required to teach the technical specialty courses in this agricultural mechanization curriculum, bearing in mind that a class of 25 to 35 students can be taught in lecture but may require two sections of 12 to 17 for laboratory work. Because the laboratory facilities may not be adequate for a group of 25

to 35 students. To be fully effective, the teaching staff must have a reasonable number of contact hours with students in formal class work. Fifteen contact hours weekly constitutes a full teaching load for the technical teacher. The balance of his time should be devoted to counseling students, further development of courses, creating teaching aids, and setting up laboratory experiences. Assistant teachers with less training may be needed to develop teaching aids, to keep the laboratory facilities functional, to maintain equipment, and to aid in grading papers. The employment of these assistants allows the teaching staffs more time for the development and improvement of course materials and promotes greater flexibility in the staff as well.

A-2. Student Selection

Students admitted to this program should be high school graduates with at least one year of high school mathematics and one year of physical science or its equivalent. In addition, a farm background and/or vocational agriculture training would be desirable.

This curriculum is designed for high school graduates with special interest in technical activities. Upon the graduation they must be capable of visualizing specific mechanical problems peculiar to the equipment studied, and they should possess the ability to analyze, diagnose, and recognize machine function and performance in their work.

Upon arrival at the school, the new students should be familiarized quickly and thoroughly with their new environment and the rules and regulations. The orientation should include an introduction to the library, laboratories, equipment, fields, field operation and organizations.

Effective guidance and counseling is basic to a sound agricultural mechanization program. The students need direction in discovering educational and employment opportunities consistent with their abilities and interests. Graduates of this program should be aided in every way possible in finding suitable employment.

A-3. Farm and Laboratory Equipment and Facilities

Farm.--A school farm or other available cropland, preferably immediately adjunct to the school laboratories and agricultural equipment shops, is required for successful teaching of an agricultural mechanization program. There should be enough land to illustrate how the crops are produced and to provide opportunities for students to operate the machinery and equipment used in all stages of crop production so they can have real experience in using, adjusting, and evaluating performance of the equipment.

Laboratory.--Laboratories and shops for teaching agricultural mechanization programs must meet high standards of quality since the objectives and the strength of the

program lies in providing valid laboratory experiences. Well-equipped laboratories with sufficient facilities for all students to perform the laboratory work are required for these courses.

A-4. Library

To achieve success in teaching an agricultural mechanization program, it is necessary to have adequate library facilities, staffed with professionally qualified personnel and knowledgeable in technological areas. Librarians must be alert to the publication of new materials, and help to keep the faculty informed of new or pertinent materials in their special fields of interest.

It is the responsibility of the teaching staff to assist the librarians in procuring pertinent materials for the library collection. The library should be used regularly by both the instructional staff and the students since this is a learning center where reliable information can always be found.

Another possible area within the scope of the library is that of audio-visual aids. Libraries, or other more specialized service departments, should develop an extensive collection of audio-visual materials. These materials should be properly previewed and selected by faculty qualified to determine their instructional value in each of the various fields within the curriculum.

A-5. Guidance Service

Guidance service should be provided to help students make the right decisions concerning occupational choices. This service provides all necessary information to help students who graduate from the program find proper and suitable employment. The function of this service could be summarized as follows:

a. Provides effective means for aiding studnets and graduates to appraise their potential employment abilities.
b. Provides means by which the students and graduates may become aware of job opportunities.
c. Provides information and advice to help qualified students apply for positions reported to be available from employers.
d. Provides means of coordinating the needs of students and graduates for employment with the needs of employers.
e. Coordinate the students summer placement (occupational experiences) program.
f. Conduct the follow-up studies on former graduated students from the program.[1]

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[1]The major source of ideas contained in A-1 through A-5 was "Agricultural Equipment Technology" (State University of New York, 1967).

APPENDIX B

COURSE OUTLINES

B-1. Applied Mathematics

Hours Required

Total hours of instruction: 54

Class: 3; Laboratory: 0.

Description

A review of mathematics integrated with the agricultural mechanization problems. This course is to familiarize the students with those problems and to develop some knowledge and confidence in solving such problems. This course includes measurement, ratio and proportion, squares and square roots, trigonometry functions and the use of the slide rule.

Course Outline

I. Measurement 10 hours

1. Standardized units of measure
2. Principle of linear measurement
3. Principle of angular and circular measure
4. Principle of surface measure
5. Principle of volume measure

II. Percentages and Averages 6 hours

1. Concept of percent and percentages
2. Application of percentage (base and rate)
3. Averages and estimates
4. Simple percentages problems

III. Ratio and Proportion 7 hours

1. The concept of ratio
2. Ratio problems
3. The concept of proportion
4. Proportion problems

IV. Squares, Square Roots and Exponents 10 hours

1. Square of whole numbers
2. Square root of whole numbers
3. Square of fraction and algebric numbers
4. Square root of fraction and algebric numbers
5. Square root table
6. Powers other than square

V. Trigonometry Functions 14 hours

1. Concept of trigonometry function
2. Solving agricultural mechanization problems with trigonometry
   a. Force diagrams
   b. Height of objects

VI. Using The Slide Rule 5 hours

1. Operation of the slide rule
   a. Multiplication

b. Division

c. Square, square root, cube, and cube root

2. Solving agricultural mechanization problems using the slide rule.

Texts and References

Fenske and others, Arithmetic in Agriculture

Olivo, Basic Mathematics Simplified, Volumes I and II

Practical Problems in Mathematics, Automotive Trades

B-2. Applied Mechanics

Hours Required

Total hours of instruction: 108

Class: 2; Laboratory: 4.

Description

This course provides students with an understanding of the basic principles of physics dealing with mechanics and heat and the ways in which these principles are directly utilized in agricultural mechanization. This understanding provides a foundation for other courses in the curriculum. Basic measurement, motion, work, energy, power, statics, and heat are included in this course.

Course Outline

I. Basic Measurement 3 hours

1. Units of measurement

2. System of measurement: metric and English
3. Use of measurement devices in agricultural mechanization: vernier caliper, micrometer, balance, spring scale

II. Motion and Momentum 9 hours

1. Speed and velocity
2. Acceleration
3. Newton's laws of motion
4. Law of gravitation (free fall)
5. Inertia
6. Circular motion: centrifugal force
7. Friction: coefficient of friction

III. Work, Energy, and Power 12 hours

1. Force: Definition, direction, amount, and units
2. Energy: definition, type
3. Power: definition, units
4. Efficiency

IV. Principles of Movement 6 hours

1. Torque
2. Levers
3. Application of principles of movements to block and tackles, loader, etc.
4. Alignment and weight shift problems encountered with various tractor hitches

V. Heat 6 hours

1. Definition
2. Temperature: scales, indicating devices, specific heat

3. Heat Transfer: conduction; convection, radiation

Laboratory 72 hours

Laboratory experiments may be completed concurrently with classroom study of the major divisions of the course or they may follow it.

1. Use of measuring devices
2. Determine weight shift and effects on alignment using various tractor hitches
3. Centrifugal and centrifugal force
4. Specific heat, and temperature measuring devices

Texts and References

Beiser, Modern Technical Physics

Joseph and others, Physics for Engineering Technology

McCormic, Fundamental of College Physics

Smith and Cooper, Elements of Physics

White, Descriptive College Physics

B-3. Service Shop

Hours Required

Total hours of instruction: 90

Class: 1; Laboratory: 4.

Description

This course is designed to acquaint students with selection, use, and maintenance of hand tools; arc and oxy-acetylene welding, brazing, cutting, hardsurfacing, threaded fasteners, micrometer reading, and identification of common metals.

Course Outline

I. Safety 3 hours
   1. Clothing
   2. Eye protection
   3. Gloves
   4. Safety rules of equipment

II. Oxy-acetylene Welding 4 hours
   1. Introduction to oxy-acetylene welding equipment and use
   2. Welding skills
      a. Running a bead and maintaining a puddle
      b. Butt welding in the flat, horizontal, and vertical position
      c. Brazing
      d. Welding cast iron with cast rod and brazing
      e. Using cutting torch
      f. Welding pipe in flat and vertical position

III. Arc Welding 4 hours
   1. Introduction to arc welding equipment and use

2. Welding skills
   a. Striking an arc and running a bead
   b. Butt, lap, and fillet welds in flat position
   c. Horizontal and vertical butt welds
   d. Welding cast iron
   e. Hard surfacing

IV. Silver Soldering 1 hour

V. Micrometer 2 hours
   1. Proper operation and use
   2. Reading micrometer

VI. Hand Tools 4 hours
   1. Identification and function of all hand tools available
   2. Proper use
   3. Maintenance of hand tools
   4. Hand tools project
      a. Micrometer operation
      b. Hacksaw operation
      c. File operation
      d. Sharpening drill bit and using
      e. Tap and die operation

Laboratory 72 hours

The time in the laboratory should be devoted to practice and performing each topic above. Each topic should be demonstrated by the instructor and practiced

by the students. Safety is of paramount importance in all shop activities and must be emphasized continuously.

Texts and References

Foss, Construction and Maintenance for Farm and Home

Giachino and others, Welding Skills and Practice

Parker, Farm Welding

L. S. Starrett Company, Starret Wall Charts and Guides for Micrometers Top and Die

B-4. Seminar(Orientation)

Hours Required

Total hours of instruction: 18

Class: 7; Laboratory: 0.

Description

This course is designed to orient the beginning student in this post-high school educational program. A brief introduction to the new type of learning situation followed by an explanation of the objectives of the program and how they will be accomplished. Job opportunities and practices in agricultural mechanization field and problems typically encountered should also be considered.

Course Outline

I. The Student and the School 4 hours

1. Physical facilities, regulations, academic requirements

2. How to plan use of time
   a. For study
   b. For student activities
3. Courses in agricultural mechanization and course relationships

II. The Library and its Use 2 hours
1. Why technicians need a library
2. Library organization
3. Services of the library staff
4. How to use the library

III. Opportunity in Agricultural Mechanization Field 3 hours
1. Government agencies
2. Private agencies
3. Manufacturers
4. Dealership
5. Credit institution
6. Others

IV. The Meaning of the Work 2 hours
1. Various concept of labor
2. "A day's labor for a day's pay" philosophy

V. Human Relation Problems 4 hours
1. Employee-employer relationships
   a. Seniority
   b. Business etiquette and ethics
2. Employee-customer relationship
   a. Appearance
   b. Policies

VI. Public Relations 3 hours

1. Importance of public relations

2. Public relations procedure

Texts and References

Davis, Human Relation at Work

Ohio State University, Human Relation in Agricultural Occupations

Reference Periodicals

Agricultural Engineering

Farm Power Equipment

Implement and Tractor

Journal of Farm Economics

B-5. Applied Electricity

Hours Required

Total hours of instruction: 108

Class: 2; Laboratory: 4.

Description

In this course the basic principles of electricity, and how these principles applied to agricultural mechanization are presented. The contents of this course are direct current, Ohms Law, magnetism, electrical motors and generators, etc.

Course Outline

I. Basic Fundamental — 3 hours
   1. Definition of electricity
   2. Conductors
   3. Insulators

II. Direct current — 9 hours
   1. Basic circuits
   2. Ohms Law
      a. Voltage
      b. Current
      C. Resistance
   3. Resistance circuits
      a. Series
      b. Parallel
      c. Combination
   4. Meters
      a. Voltmeter
      b. Ammeter
      c. Ohmmeter

III. Magnetism — 9 hours
   1. Electromagnet
   2. Polarity
   3. Magnetic Field
   4. Induction
   5. Right hand rule
   6. Magnetic force on conductor

IV.	Capacitor	2 hours
V.	Transformers	3 hours
VI.	Rectifiers	5 hours
	1. Type	
	2. Circuits	
	3. Use	
VII.	Electric Motors	5 hours

Laboratory 72 hours

The laboratory time in this course is used to perform experiments to learn and demonstrate the physical principal of electricity. Some of those practices can be as follows:

1. Demonstrate electromagnetic induction
2. Ohm's Law power factors
3. Tramsformers, simple generators, and motors

Texts and References

American Association for Agricultural Engineering and Vocational Agriculture, Electrical Terms

_____, Farm Electric Motors-Section, Protection

Brown, Farm Electrification

Kitts and Nabben, Farm Electricity

Visual Aids

Electric Power and Common Sense, 28 min., 16 mm., sd., color. New York State Electricity and Gas Corp., 62 Henry Street, Binghamton, N.Y. 13905.

How Electric Motors Start and Run, 35 min. filmstrip, American Assoc. for Agricultural Engineering and Vocational Education, Athens, Georgia 30601.

B-6. Small Engines

Hours Required

Total hours of instruction: 108

Class: 2; Laboratory: 4.

Description

This course is developed to present to the students the basic fundamental, parts identification and functions, disassembling, measuring, repairing, and reassembling of small gasoline engines such as those found in two wheeled tractors, lawn mowers, and rototillers.

Course Outline

I. Introduction to Basic Engine 4 hours
   1. Parts identification and functions
   2. Operation principles for 2 and 4 cycle engines

II. Electrical System 9 hours
   1. Magnetism
   2. Magneto
   3. Primary circuit
   4. Secondary circuit

III. Fuel System 9 hours

1. Study of fuel
2. Carburetion and carburetor

IV. Lubrication System 6 hours

1. Functions of oil and lubrication
2. System of lubrication: pressure system, splash system, and gravity system

V. Engine Repair 8 hours

1. Visual inspection
2. Disassembly
3. Measurement
4. Repair
5. Assembly
6. Final adjustment

Laboratory 72 hours

The time in laboratory should be used for testing, diagnosing, disassembling, inspecting, repairing, and reassembling various small engines.

Texts and References

Briggs and Stratton Corporation, Briggs and Stratton Service Manual

Clinton Service Corporation, Clinton Service Manual

Goodheart-Willcox Company, Inc., All About Small Gas Engines

Technical Publication, Inc., I and T Service Manual

Technical Publication, Inc., Small Engine Service and Manual

B-7. Farm Tractors

Hours Required

Total hours of instruction: 162

Class: 3; Laboratory: 6.

Description

This course deals primarily with the components, systems, operation and control of wheels and crawler tractors. Engine and hydraulic systems are excluded. An understanding and application of the fundamentals and principles of mechanical systems of power transmission is stressed with particular emphasis placed on transmissions and final drives.

Course Outline

I. Gears and Bearings — 5 hours
   1. Gears types and applications
   2. Gear ratios
   3. Bearing types and applications
   4. Service and maintenance

II. Friction Clutches — 3 hours
   1. General designs and characteristics
   2. Application and control of various designs
   3. Clutch adjustment and repair

III. P.T.O., Belts and Pulleys 6 hours

1. ASAE speed and dimensional standards
2. Controls and power trains from PTO operation
3. Pulleys and belts
   a. Size
   b. Speed
   c. Materials
4. Controls and power train for belt-pulley operation
5. Service and maintenance

IV. Transmissions 12 hours

1. Relationship between power, speed, and torque
2. Types
   a. Single shift
   b. Dual shift
   c. Shift-on-the-go
3. Service and maintenance
   a. Lubrication
   b. Inspection
   c. Repair

V. Differentials 3 hours

1. Function and component
2. Principles of operation
3. Service and inspection

VI. Final Drive 3 hours

1. Types and function
2. Service and maintenance

VII. Steering 5 hours

1. Types and components on wheel tractors
2. Types and components on crawler tractors
3. Adjusting and servicing

VIII. Brakes 5 hours

1. Type
2. Principles of operation
3. Components
4. Adjusting and servicing

IX. Wheels, Tires, and Tracks 7 hours

1. Wheel types
2. Tires
   a. Size
   b. Tread design
   c. Pressure, care, and service
3. Tracks
   a. Types
   b. Undercarriage
   c. Check for wear, servicing, and repair

X. Tractors stability and Traction Devices 5 hours

1. Weight, traction, and rolling resistance relationships
2. Distribution of weight and pressure
   a. Applied to soil
   b. Effect of drawbar pull and heights of hitch point

c. Influence of mounted implements, vertical loads, and terrain on stability

3. Nebraska test interpretation

Laboratory 108 hours

The laboratory periods will be used to study and examine the different kinds of power transmissions and driving systems including clutches, transmission, differentials, final drives, PTO, steering systems, brakes and tires. Identification of parts and function, determining gear ratio, and repair of each system. Some laboratory periods should be used in the field to study traction and tractor stability. Safety should be emphasized in all aspects of the course.

Texts and References

Annual Farm Equipment Red Book

Barger and others, Tractors and Their Power Units

Frazee and others, Automotive Brakes and Power Transmission Systems

B. F. Goodrich Co., What You Should Know about Farm Tires

Jones, Farm Gas Engines and Tractors

Manufacturers Services and Operators Manuals

Visual Aids

Brake System, 22" × 34" chart, Public Relations Staff, G.M. Technical Center, Warren, Michigan 48090.

Rear Axle Assembly, 22" × 34" chart, Public Relations Staff, G.M. Technical Center, Warren, Michigan.

Three Speed Gear Transmission, 22" × 34" chart, Public Relations Staff, G.M. Technical Center, Warren, Michigan.

B-8. Gas Engines

Hours Required

Total hours of instruction: 162

Class: 3; Laboratory: 6.

Description

This course is a study of principles of internal combustion engines. Various types of engines used in farms and light industrials are studied together with the design and the construction of engine components and systems. Diagnosing engine problems, servicing, and repairing of farm power units are presented. Safety is emphasized and practiced throughout the course.

Course Outline

I.	History and Development of Tractors and Power Units	2 hours
II.	Engine Types	2 hours
	1. Gasoline	
	2. Diesel	

3. L.P. gas
4. Gas turbine
5. Fuel cell
6. Others

III. Power and Its Measurement 4 hours

1. Definitions
2. Power calculations
3. Nebraska tests
4. Trends in power and tractor size
5. Power losses from accessories

IV. Internal Combustion Principles 4 hours

1. Thermodynamic principles and application
2. Engine cycles and principles of operation
3. Engine efficiency
4. Bore-stroke ratio
5. Compression ratio and displacement

V. Engine Construction and Design 6 hours

1. Engine parts and their functions
2. Materials of construction
3. Crankshafts and firing orders
4. Engine balance
5. Valve design, materials, timing servicing
6. Combustion chamber design

VI. Fuel and Combustion 4 hours

1. Type and Composition of fuel
2. Gasoline octane number, anti-knock, volatility, additives

3. Fuel filters

VII. Carburetion and Carburetors 6 hours

1. Carburetion principle
   a. Fuel-air ratio
   b. Fuel and air flow
   c. Starting, ideling, and compensation
2. Types of carburetors
3. Carburetor adjustment
4. L.P. Gas equipment

VIII. Electrical System 8 hours

1. Battery
   a. The principle of wet storage batteries
   b. Testing batteries and maintenance
2. Generators, alternators and starters
   a. Principles
   b. Testing and repairs
3. Regulators principle
4. Ignition system
   a. Ignition coil
   b. Distributor
      (1) Testing
      (2) Repairing
      (3) Timing
   c. Spark plugs testing and maintenance

IX. Air Cleaners and Cooling Systems 2 hours

1. Type of air cleaner

2. Servicing air cleaner
3. Type of cooling systems
4. Servicing cooling systems

X. Governing and Governors — 2 hours
1. Principles and systems
2. Governing mechanism and types
3. Servicing governing systems

XI. Lubricants and Lubrication System — 4 hours
1. Types of lubricants
2. SAE and API classification
3. Additives
4. Splash and force feed systems
5. Bearings and bearings lubrication
6. Crankcase ventilation

XII. Engine Repair — 10 hours
1. Farm, light industrial service procedure
   a. Use of service manuals
   b. Use of tools and service equipment
   c. Step-by-step repair procedure
2. Condition of parts affecting compression, e.g., rings, valves
3. Conditions affecting oil consumption
4. Conditions relating to excessive noise, e.g., main or rod bearings
5. Break-in procedure
6. Final tune-up

Laboratory 108 hours

The laboratory activities include testing, servicing, adjusting, diagnosing, disassembling, inspecting, repairing and reassembling various engines. Zero defects will be the goal of all repair work. Using tractors or stationary engines the instructor must demonstrate each activity followed by students practices. The tune-up engine or overhauling should include power testing before and after the job is done.

Texts and References

American Association for Agricultural Engineering, Tractor Maintenance

American Oil Company Engineering Bulletin FT-53, Farm Tractors

Barger and others, Tractors and Their Power Units

Crouse, Automotive Mechanics

Frazee and Bedell, Automotive Fuel and Ignition Systems

B. F. Goodrich Co., What You Should Know About Farm Tires

Jones, Farm Gas Engines and Tractors

Toboldt and Purvis, Motor Service's Automotive Encyclopedia

Wetzel, Automotive Diagnosis and Tune-Up

Visual Aids

The ABC of the Automobile Engine, 18 min., 16 mm., sd., color, Film Library, General Motors Corp., General Motor Bldg., Detroit, Michigan 48202.

The ABC of Internal Combustion, 13 min., 16 mm., sd., color, Film Library, General Motors Building, Detroit, Michigan.

B-9. Planting and Tillage Equipment

Hours Required

Total hours of instruction: 162

Class: 3; Laboratory: 6.

Description

This course is designed to acquaint the student with the principles and conditions of field operation of planting and tillage machinery. The principles of construction, operational speed, rated loads, and power required and loss are included. Principles and methods of testing, calibrating, and adjusting the machine before and during field operation are emphasized, repairs are made, and safety procedures are developed.

Course Outline

I. Introduction to Farm Machines 5 hours

1. Principle of design and operation
2. Materials of construction
3. Mechanical power transmission
   a. Direct
   b. Belts

c. Chains

d. Gears

e. Protective devices

4. Hydraulic lifts

5. Lubrication

a. Purpose

b. Types

c. Methods of application

II. Primary Tillage 16 hours

1 Plow

a. Moldboard

b. Disk

c. Rotary

d. Chisel and subsurface

2. Garden tillage equipment

a. Small plows and rotary tillers

(1) Size and types

(2) Adjustment

3. Selection

a. Type of soil

b. Number of acres

c. Machine performance

(1) Capacities

(2) Field patterns

(3) Performance testing

d. Machinery costs

(1) Fixed

(2) Variable

4. Field Use

a. Adjustment

b. Speeds

5. Maintenance

a. Cleaning and checking

b. Repairing

c. Storage

III. Secondary Tillage Equipment 10 hours

1. Harrows

a. Disk

b. Spike-tooth

c. Spring-tooth

d. Special

2. Other seeded preparation tools

a. Land rollers and pulverizers

b. Subsurface tillage tools and field cultivators

c. Rotary hoe

3. Selection

a. Type of soil

b. Number of acres

c. Machine performance

d. Power performance

e. Machinery costs

4. Field Use
   a. Adjustment
   b. Speeds
5. Maintenance
   a. Cleaning and checking
   b. Repairing
   c. Storing

IV. Planting Equipment 14 hours

1. Row crop planters
   a. Corn
   b. Cotton
   c. Beet and bean
   d. Potato
   e. Transplanting or plant-setting machines
   f. Vegetable planters and other precision planters
2. Broadcast and drill planters
   a. Grain drills
   b. Multiple-use drills
   c. Grass spring planters
3. Selection
   a. Type of seed
   b. Number of acres
   c. Machine performance
   d. Machinery costs
4. Field Use
   a. Adjustment or setting
   b. Speeds

5. Maintenance
   a. Cleaning
   b. Repairing
   c. Storing

V. Weed-Control Equipment 6 hours
1. Flame
2. Chemical
   a. Sprayer
   b. Duster
3. Cultivators
4. Selection of equipment
   a. Kind of crops
   b. Number of acres
   c. Machine selection and economic performance
   d. Machinery costs

VI. Lawn Mowing Equipment 3 hours
1. Rotary mowers
2. Reel mowers

Laboratory 108 hours

During the first half of the semester the laboratory will be conducted in the field to give experience in the safe operation of the various field machines and to provide the opportunity to make preliminary adjustments in the shop and final adjustment under field contion. In the second half of the semester, students will service

machines, order parts, and make actual machine repairs. The following activities may be performed in laboratory work:

A. In the Field
   1. Instruction in tractor driving and safe operation
   2. Plowing with trailer and mounted plow and making proper adjustment
   3. Using different types of secondary tillage
   4. Row crop planters use and adjustment
   5. Broadcast-type planters
   6. Weed-control sprayer and duster

B. In the Shop
   1. Lubrication and storage of equipment
   2. Checking and replacing worn, broken or bent posts
   3. Calibrating and repairing planters
   4. Reconditioning secondary tillage equipment
   5. Special problems: hydraulic lifts and controls power transmission, etc.

Texts and References

Bainer and others, Principles of Farm Machinery

Hunt, Farm Power and Machinery Management

Smith, Farm Machinery and Equipment

Operators' and Service Manual from the various manufacturers

Machinery Chart from Agricultural Machinery manufacturers

B-10. Hydraulic Systems

Hours Required

Total hours of instruction: 72

Class: 2; Laboratory: 2.

Description

In this course the basic fundamental and the principles of the hydraulic system are presented. Application of hydraulic to agricultural equipment is emphasized. The hydraulic motors, cylinders, valves, seals and the servicing, and minor repairing of hydraulic systems are studied.

Course Outline

I. Introduction 2 hours
   1. History of hydraulic development
   2. Advantages and application of field power

II. Fluid Power Principle 6 hours
   1. Pascalis Law
   2. Hydrastatics and hydrodynamics

III. Fundamental Circuit 10 hours
   1. Pump
      a. Gear
      b. Vane
      c. Piston

2. Valves
   a. Spool
   b. Rotary
   c. Flow divider
3. Motor
   a. Piston
   b. Gear
   c. Vane
4. Cylinder
   a. Single acting
   b. Double acting

IV. Hydraulic System 4 hours
1. Open center
2. Close center

V. Tractor Hydraulic Lift System 12 hours
1. Component, design, and operating principle
2. Depth and position control, weight transfer principle
3. Adjusting and servicing

VI. Hydraulic Maintenance 2 hours
1. Filters
2. Strainers
3. Flushing a system
4. Servicing and maintenance

Laboratory 36 hours

Familiarization with the component, circuits and systems should be stressed. Disassembly, testing, repairing and reassembling of the pumps, valves, cylinders, motors, and tractor hydraulic lift system should be included in laboratory activities.

Texts and References

American Association for Agricultural Engineering and Vocational Agriculture, Tractor Hydraulics

International Harvester Company, Hydraulics

Texaco, Hydraulic Machinery

Visual Aids

Application of Pascal's Law, Part I and II, 15 min., 16 mm., sd., color, Gov't. Film Dept., United World Film, 1445 Park Ave., New York, N.Y. 10016.

Basic Hydraulic, 15 min., 16 mm., sd., color, Gov't Film Dept., United World Film, 1445 Park Ave., New York, N.Y.

B-11. Diesel Engines

Hours Required

Total hours of instruction: 108

Class: 2; Laboratory: 4.

Description

This course presents the principles of design and construction of different types of diesel engines on farms and in light industrial applications. Since many aspects of engines have been studied in "Gas Engines" course, the emphasis in this course is on types of engine chamber design and injection system. Theory and principles will be studied under actual and practical conditions by running, testing, disassembling and reassembling components, systems and engines. Safety is emphasized throughout the course.

Course Outline

I. History of Diesel Engines 1 hours

II. Comparison of Diesel and Gas Engines 2 hours

1. Original costs
2. Fuel and operation costs
3. Operation, maintenance, and repair

III. Engine Construction, Design and Types 3 hours

1. Classification by size, speed, and use
2. Two- and four-cycle engines
3. Scavenging and supercharging

IV. Fuels and Combustion 3 hours

1. Cetane rating
2. Combustion and heat valuves
3. Ignition log, diesel knock

V. Engine Power, Rating and Performance 3 hours

1. Power calculation
2. Power losses
3. Indicated and brake horsepower, efficiency

VI. Combustion chambers; thermodynamic characteristics 4 hours

1. Principle of combustion
   a. Turbulence
   b. Compression ratio
   c. Combustion stage
2. Type of chambers
   a. Direct injection
   b. Precombustion
   c. Turbulence
   d. Auxiliary

VII. Fuel Injection Systems 5 hours

1. Common rail
2. Jerk pump
3. Distributor

VIII. Principles and Characteristics of Injectors, Nozzles and Pumps 8 hours

1. Unit injectors
2. Single hole, multiple hole and pintle nozzles
3. Spry patterns
4. Types of pumps--American Bosch, C.A.V., caterpillar, etc.

IX. Blowers, Superchargers and their Application — 3 hours

1. Part and valve scavenging blowers
2. Supercharger with rotary or centrifugal blowers
3. Turbocharger

X. Starting Systems — 2 hours

1. Compressed air
2. Gasoline engine
3. Electric starting
4. Cold weather starting aids

XI. Governors — 2 hours

1. Mechanical
2. Hydraulic

Laboratory — 72 hours

Laboratory activities may be completed concurrently with class discussion, or it may follow. As many of the following topics as time permits should be studied:

1. Starting and running engines
2. Fuel injection nozzles
3. Nozzle testing
4. Unit injectors and testing
5. Fuel injector pumps calibration
6. Troubleshooting and testing engines
7. Engine service and maintenance

Texts and References

Armstrong and Hartman, The Diesel Engines

Barger and others, Tractors and Their Power Units

Fox, Diesel Operation and Fault Diagnosis

Judge, High Speed Diesel Engines

Kates, Diesel and High-Compression Gas Engines

Maleev, Diesel Engine Operation and Maintenance

Smith, The Modern Diesel

Visual Aids

The ABC of Diesel Engines, 18 min., 16 mm., sd., color, Film Library, General Motors Bldg., Detroit, Michigan 48202.

Detroit Diesel Engine Instruction Charts, Detroit General Motors Division, General Motors Corp., Detroit, Michigan 48202.

Engine Tune-Up Procedure Filmstrip, Detroit Diesel Engine Division.

The GM Diesel Engine Filmstrip, Detroit Diesel Engine Division.

B-12. Harvesting Equipment

Hours required

Total hours of instruction: 108

Class: 2; Laboratory: 4.

Description

This course is a continuation of the study of farm machinery. In this course emphasis will be placed on operation, adjustment, repairing, and safety of harvesting equipment. Field opeation will be used to provide a fuller understanding of the performance of a particular machine as influenced by design, speed, capacity and adjustment. Basic principles are developed through discussion and demonstration, supported by a carefully integrated program of laboratory experience. The repair program develops skills in the use of testing devices and provides students an ability to evaluate mechanical elements and solve the problems encountered in harvesting equipment.

Course Outline

The following topics will be studied for hay, grain, corn, cotton, and root harvesting machinery:

I. Introduction to Machinery — 2 hours
   1. History of development
   2. Purpose
   3. Advantages and disadvantages
   4. Terminology

II. Powering — 2 hours
   1. Power taken from the pulling tractor
   2. Auxiliary engine
   3. Self-propelled

III.	Mechanism and Flow Pattern	5 hours
	1. Cutting	
	2. Feeding	
	3. Processing	
IV.	Adjustment	3 hours
V.	Characteristics of the Machine	4 hours
	1. Capacity	
	2. Safety	
	3. Crops losses	
VI.	Power Train	3 hours
	1. Source of power	
	2. Main drive shaft	
	3. Distribution of power to cutting, feeding, and processing systems	
VII.	Lubrication Systems	2 hours
VIII.	Protective Devices and Safety	2 hours
	1. Slip clutches	
	2. Shields	
IX.	Special Equipment and Attachments	2 hours
X.	Hydraulic Systems	3 hours
XI.	Trouble Shooting and Repair	5 hours
XII.	Economic of Owning Equipment	3 hours
	1. Overhead costs	
	2. Operation cost	
	3. Custom works and custom rates	

Laboratory 72 hours

The first half of the semester is devoted to the operation, adjustment, and servicing of the harvesting machinery. The second half of the semester is devoted to working in shop with the machines that were used in the field. Shop activities include checking, cleaning, replacing and fixing worn and broken parts, and storage. Safety should be emphasized through the course.

Texts and References

Annual Farm Equipment Red Book

Facts About Storage Batteries, Bulletin

Hay Conditioners, Bulletin #339

Hunt, Farm Power and Machinery Management

Smith, Farm Machinery and Equipment

Operators' and Service Manuals from various manufacturers

Visual Aids

Miracles of Paradise Valley, 40 min., 16 mm., sd., Film Laboratory, Cornell University, Roberts Hall, Ithaca, New York, 14850.

B-13. Power Unit Testing and Diagnosis

Hours required

Total hours of instruction: 108

Class: 2; Laboratory: 4.

Description

This course is based on the principles studied in the electricity, mechanics, and engine courses. The electrical and mechanical systems and components of tractors and power units will be tested. Testing will include the use of simple testing devices as well as the most recent electrical testing and diagnostic equipment available. Malfunctions and their interrelationship with components and systems will be studied, with particular emphasis placed on the use of a logical sequence of steps in testing and diagnosing of malfunctions, and the adjustment and repair or tune-up of power units.

Course Outline

I. Principle of Power Units
   Testing and Diagnosis — 8 hours
   1. Introduction
   2. Review of principles of operation of gas and diesel engines
   3. Type of testing equipment
   4. Systematic approach to testing and diagnosis

II. Engine evaluation and diagnosing component/system troubles — 24 hours
   1. Dynamometer
      a. Horse power
      b. Torque

c. Smoke evidence

d. Engine RPM

e. Rated

2. Compression

3. Leakage

4. Lubrication system

5. Valve clearance

6. Exhaust analysis

7. Fuel system analysis

8. The charging circuit

a. Storage battery

b. Generator

c. Alternator

d. Voltage regulator

9. Ignition system

a. Coil

b. Condenser

c. Distributor

d. Spark plugs

e. Wiring harness

f. Timing

g. Magneto

10. Cooling system

III. Operating the Tune-Up Shop 9 hours

1. Tune-Up procedure

2. Testing equipment needed

3. Shop operating procedure
4. Farm calls
5. Record keeping

Laboratory

The library time should be utilized by the student to test the components that have been studied. Each student should become familiar with all equipment in the laboratory. Several of the laboratory periods near the end of the course should be devoted to diagnosing tractors and power unit malfunctions.

Texts and References

AC Spark Plug, Acilloscope and Tune-Up Manual

Automotive Electric Association, Tune-Up Manual

Barger and others, Tractors and their Power Units

Delco-Remy Division, Better Ignition

Frazee and Bedell, Automotive Fuel and Ignition Systems

Venk and Billiet, Automotive Engines Maintenance and Repair

Wetzel, Automotive Diagnosis and Tune-Up

Visual Aids

The ABC of Internal Combustion, 13 min., 16 mm., color, sd., Public Relations Staff, Film Laboratory, General Motors Bldg., Detroit, Michigan.

Better Ignition, 22 min. filmstrip, sd., Technical Literature Dept., Delco-Remy Division, Anderson, Indiana 46011.

B-14. Occupational Experience
(Summer Session)

Occupational experience is defined as student participation in the operation of an agricultural business or a farm, under a plan approved and supervised by the institution. Supervised occupational experience is essential for an adequate educational program in agricultural mechanization. It will develop on-the-job competencies needed by a student for gainful employment in an agricultural occupation. Objectives of such plans include the following:

1. To prepare each student for gainful employment in an occupation in his field of interest.
2. To provide the student with the opportunity to gain a sense of responsibility for a job.
3. To provide the student with the opportunity to develop positive on-the-job personality traits.
4. To provide the student with the opportunity to apply in practice the theory and knowledge gained in the classrooms and laboratories.
5. To provide the student with the opportunity to learn to cooperate and work with fellow employees and customers.
6. To provide students with an opportunity to gain knowledge and experience in aspects of jobs not available at the school.

After the arrangements have been completed with employers to use the work opportunities they provide, and before initiating the actual student work experience, cooperative work agreements with each employer should be prepared. These agreements should include a statement of philosophy and the responsibilities of all parties. They should specify the occupational experience the student will receive, time requirement for each job experience, wages, insurance, working hours, and time-off conditions.

Progress and evaluation records should be completed for each student and filed with the permanent student records at the school. The following information should be included:

1. Employer's rating report
2. Instructor's rating report
3. Visitation report
4. Student work experience report
5. Copies of training plan and agreement
6. Evaluation form

APPENDIX C

THE JURY OF EXPERTS

Technicians Sub-Jury

Technicians from eight major companies who cooperated with this study:

Mr. R. T. Armstrong — Birmingham, Michigan
Ford Motor Co.

Mr. J. E. Gillings — Lansing, Michigan
J. I. Case Co.

Mr. Wayne Gillispie — Lansing, Michigan
International Harvester Co.

Mr. Richard Ingall — Lansing, Michigan
John Deere Co.

Mr. Gary Jarstfer — Lansing, Michigan
Massey-Ferguson, Inc.

Mr. Clarence Kloosterhouse
Allis-Chalmers Co.

Mr. James Mortland — White Cloud, Michigan
Minneapolis-Moline

Mr. George Pierson — Columbus, Ohio
Oliver

Teachers Sub-Jury

Teachers of farm equipment service and sales:

Mr. Howard Acott Dodge City Community Junior College
Dodge City, Kansas

Mr. Roger Holcomb North Iowa Area Community College
Mason City, Iowa

Mr. Oscar Kimmel Pennsylvania State University
University Park, Pennsylvania

Mr. Miles Lovingood Clark County Technical Institute
Springfield, Ohio

Mr. Elmer Miller Central Nebraska Tech
Hastings, Nebraska

Mr. Edward Mott Cobleskill Agriculture and Technical College
Cobleskill, New York

Mr. Keith Stenens Nebraska Vocational Technical School
Milford, Nebraska

Mr. L. W. Williams Iowa Western Community College
Council Bluffs, Iowa

Educators Sub-Jury

Educators engaged in teaching agricultural power and machinery at Michigan State University:

Carl Albrecht, Professor of Agricultural Engineering

Richard Bittner, Professor of Agricultural Engineering

Clarence Hansen, Professor of Agricultural Engineering

Chester Mackson, Professor of Agricultural Engineering

Howard McColly, Professor of Agricultural Engineering

Sverker Persson, Professor of Agricultural Engineering

Guy Timmons, Professor of Agricultural Education

Robert White, Professor of Agricultural Engineering

APPENDIX D

SAMPLE COPIES OF LETTERS SENT TO PERSONNEL DIRECTORS AND SELECTED TECHNICIANS OF EIGHT MAJOR AGRICULTURAL EQUIPMENT COMPANIES

April 10, 1968

Mr. Gene Bruhn
John Deere Company
3400 North Grand River
Lansing, Michigan 48906

Dear Mr. Bruhn:

The John Deere Company for which you are a representative, is a significant leader in the production of agricultural machinery used throughout the world. With this thought in mind I am coming to you for help in gathering information which I need for completing a study, the purpose of which is to assist in clarifying the requirements necessary for training farm machinery and equipment technicians. This study will be a part of my doctoral program at Michigan State University.

I need to make contact with one of your technicians so as to learn more about the kinds of technical jobs handled by him. Will you please send me the name and the address of one of your most outstanding technicians. By word "technician" I am refering to a person who may have the following qualifications:

1. Has at least two years of post-high school farm equipment training;

2. Is currently dealing with repairing farm machinery and equipment;

3. Has at least two years experience in repairing farm machinery and tractors;

4. Has at least one year of overseas experience dealing with farm machinery.

I would like to thank you in advance for your help and cooperation which will be very much appreciated.

Very truly yours,

Soleiman Zareian

COVER LETTER TO THE TECHNICIANS

April 25, 1968

Mr. R. T. Armstrong
Gen. Field Mgr. - N. Central Dist.
50000 Grand River Expressway
Wixom, Michigan 48096

Dear Mr. Armstrong:

You have been recommended to me as one of the most outstanding employees representing your company. With this knowledge in mind I am asking for your assistance in completing a study, the purpose of which is to determine what kinds of technical skills are needed by the technicians who are servicing, adjusting, and repairing farm equipment and tractors. This study will be of assistance in planning future training programs for agricultural mechanization technicians in Iran and will be a part of my doctoral program at Michigan State University.

Enclosed I am sending you a list of activities. I would like to have you rate this list. Based upon your own judgement and experience, simply check (✓) the one block which indicates how important you think it is for a technician to be able to perform that item.

You will find enclosed a stamped, self-addressed envelope for your convenience in returning the completed list.

I would like to thank you in advance for your help and cooperation which will be very appreciated.

Very sincerely yours,

Soleiman Zareian

SZ:jd
Encl. (2)

COVER LETTER TO THE TEACHERS

April 24, 1968

Dr. Roger Holcomb
North Iowa Area Community College
220 East State Street
Mason City, Iowa

Dear Dr. Holcomb:

Your institution is recognized as having a very significant farm equipment training program. With this thought in mind, I am asking you for assistance in gathering information which I need for completing a study, the purpose of which is to assist in clarifying the requirements necessary for training farm machinery and equipment technicians. This study will be of assistance in planning future training programs for agricultural mechanization technicians in Iran and will be a part of my doctoral program at Michigan State University.

Enclosed I am sending you a list of activities. I would like to have you rate this list. Based upon your own judgement and experience, simply check (√) the one block which indicates how important you think it is for a technician to be able to perform that item.

You will find enclosed a stamped, self-addressed envelope for your convenience in returning the completed list.

I would like to thank you in advance for your help and cooperation and will be happy to send you a brief summary of the findings of this study if you so desire it.

Very sincerely yours,

Soleiman Zareian

Enclosures

APPENDIX E

Table 3.--Weighted Means and Rank Order for 70 Competencies for Three Sub-Juries and the Total Jury

Rank Order	Competencies	Weighted Means			
		Technicians N=8	Teachers N=8	Educators N=8	Total Jury N=24
	Basic Science				
1	Elementary Electricity	3.00	3.00	3.00	3.00
2	Elementary Mechanics	2.79	3.00	2.93	2.91
3	Technical Drawing	2.61	2.43	2.02	2.21
4	Applied Arithmetics	2.11	2.35	1.91	2.13
5	Elementary Algebra	1.79	2.34	1.95	1.89
	Service Shop				
6	Proper selection of tools, use and care	3.00	3.00	3.00	3.00
7	Using right tools for the right jobs	3.00	3.00	3.00	3.00
8	Performing hand tools and power tools operation	3.00	3.00	2.87	2.95
9	Reading and using micrometer	3.00	2.87	3.00	2.95
10	Proper storage of tools and shop equipment	2.81	2.40	2.75	2.60
11	Using welding equipment	2.81	2.40	2.75	2.60
12	Constructing labor-saving equipment	2.52	2.10	2.00	2.20

Table 3.--Continued.

Rank Order	Competencies	Weighted Means			
		Technicians	Teachers	Educators	Total Jury
	Small Engines				
13	Servicing and maintenance	3.00	3.00	3.00	3.00
14	Perform basic trouble-shooting	3.00	3.00	3.00	3.00
15	Repairing and reconditioning ignition and fuel systems	3.00	3.00	3.00	3.00
16	Complete engine overhaul	2.41	2.61	2.50	2.51
	Internal Combustion Engines				
17	Servicing the air cleaner	3.00	3.00	3.00	3.00
18	Servicing, adjusting, and repairing carburetor	3.00	3.00	3.00	3.00
19	Measurement of compression on all cylinders	3.00	3.00	3.00	3.00
20	Tune-up engines	3.00	3.00	3.00	3.00
21	Adjusting engine valuve tappets	3.00	3.00	3.00	3.00
22	Adjusting and replacing distributor point	3.00	2.90	2.90	2.95
23	Timing ignition system	2.87	3.00	3.00	2.95
24	Maintenance and repair of oil system	3.00	3.00	2.87	2.95
25	Operating and maintenance of diesel engines	3.00	3.00	2.85	2.95
26	Adjusting governor	2.85	3.00	3.00	2.95
27	Engine reconditioning	3.00	3.00	2.87	2.95
28	Servicing battery	3.00	2.75	3.00	2.91
29	Servicing and flushing cooling system	3.00	2.91	2.82	2.91
30	Replacing piston rings	3.00	3.00	2.70	2.90

Table 3.--Continued.

Rank Order	Competencies	Weighted Means			
		Technicians	Teachers	Educators	Total Jury
31	Servicing generators and starters	2.81	3.00	2.60	2.80
32	Grinding and fitting valves	2.30	2.71	2.50	2.51
33	Repairing radiator	2.20	2.40	2.60	2.40
34	Servicing fuel and injection system	2.60	2.10	2.50	2.40
35	Overhauling gasoline, L.P. gas, and diesel engines	2.00	1.90	2.00	1.95
	Farm Tractors				
36	Servicing the tractor regularly	3.00	3.00	3.00	3.00
37	Performing proper hitching and shop and field testing	3.00	3.00	3.00	3.00
38	Adjusting tractor brakes	3.00	3.00	3.00	3.00
39	Adjusting the load fuel-air mixture	3.00	3.00	3.00	3.00
40	Servicing and correct using of power take-off system	3.00	3.00	2.87	2.95
41	Servicing transmission and final drive	3.00	3.00	2.71	2.90
42	Performing tractor wheel-spacing	2.81	2.90	2.71	2.81
43	Complete tractor overhaul	2.40	2.10	2.10	2.21
	Farm Machinery				
44	Proper use of service and operators manual	3.00	3.00	3.00	3.00
45	Adjusting plow vertically and horizontally	3.00	3.00	3.00	3.00

Table 3.--Continued.

Rank Order	Competencies	Weighted Means			
		Technicians	Teachers	Educators	Total Jury
46	Adjusting farm machinery under field condition	3.00	3.00	3.00	3.00
47	Identifying faulty parts--repair or replace them	3.00	3.00	3.00	3.00
48	Safety in operation of all machinery	3.00	3.00	3.00	3.00
49	Calibrating planters and seeding drills	3.00	3.00	2.75	2.91
50	Adjusting baler for proper operation	3.00	2.91	2.80	2.90
51	Adjusting combine for proper operation	3.00	2.90	2.87	2.80
52	Aligning mover cutter bar guards	3.00	2.70	2.85	2.85
53	Machinery set up	2.80	2.73	3.00	2.85
54	Adjusting corn pickers, cotton pickers, sugar beets and potato harvester for proper operation	3.00	2.70	2.75	2.80
55	Registering the knives of mower	3.00	2.70	2.35	2.75
56	Adjusting and using thinning, prunning, and cultivating equipment	2.61	2.30	2.75	2.55
57	Measuring combine harvesting losses	2.61	2.25	2.37	2.40
58	Machinery storage	2.50	2.41	2.32	2.40
59	Painting farm machinery	2.00	2.11	1.81	1.90
60	Calibrating fertilizer equipment	2.01	1.90	1.82	1.85

Table 3.--Continued.

Rank Order	Competencies	Weighted Means			
		Technicians	Teachers	Educators	Total Jury
	Hydraulic Systems				
61	Understanding the principle of hydraulic system	3.00	3.00	3.00	3.00
62	Understanding the function of hydraulic motors, pumps and valves	3.00	3.00	3.00	3.00
63	Maintenance of hydraulic systems in farm machinery	3.00	3.00	2.75	2.95
	Power Transmission				
64	Performing clutch adjustment and repair	3.00	3.00	2.87	2.95
65	Selecting and using farm belts and pulleys	2.81	2.70	2.75	2.75
66	Determining size of pulleys and belts	2.61	2.60	2.50	2.56
67	Calculating gear ratio and belts length	2.30	2.40	2.50	2.40
	Agricultural Machinery Management				
68	Determining capacity and performance of farm machinery	2.80	2.71	2.95	2.80
69	Determining custom rate of farm equipment	2.50	2.70	2.60	2.60
70	Selecting proper machinery and tractors	2.41	2.90	2.25	2.50

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