

TEACHING UNITS IN FARM MECHANICS  
FOR COURSES OF STUDY IN  
ARIZONA DEPARTMENTS OF VOCATIONAL AGRICULTURE

By  
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Report on a Problem  
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## PART I

## INTRODUCTION

## Justification for the Study

There is a need for improvement in the farm mechanics instruction in Arizona departments of vocational agriculture. Some educators believe there is more room for improvement in this area than in any other phase of the vocational agriculture program. The major conditions responsible for this situation are: lack of properly trained instructors, inadequate facilities, and lack of systematic instruction. Since the first two of these factors have been improved considerably in the last few years, it would seem that further improvement of the farm mechanics program should be made by encouraging the use of more systematic instruction in the teaching of farm mechanics.

An organized course of study is needed, not only to determine what to teach and how to teach it, but also to serve as a guide in planning and procuring farm mechanics buildings and equipment. A course of study would also be of much value in selecting content for training farm mechanics instructors.

There is a major trend toward more use of definite courses of study by departments of vocational agriculture throughout the United States. Course guides in both the production phase and the farm mechanics phase of vocational agriculture are being favorably received and increasingly used by the teachers in the different states.

Although there is a trend toward the development of uniform courses of study within states, there is much variation in the content of farm mechanics courses of study, not only among states but also in the different agricultural departments in a state. Yet most of the abilities in farm mechanics needed by students are uniform in nature and are more adapted to the use of a uniform course guide than are many other phases of the instruction in vocational agriculture.

There is also a trend toward less total time for vocational agriculture programs in the high schools. For example, for a number of years the United States Office of Education has recommended "Two consecutive 60-minute periods of instruction per day, 5 days per week, for each class, each year"<sup>1</sup> as one of the minimum time provisions for a high school course in vocational agriculture. Recently the following plan has been added to the list of minimum provisions;

Sixty minutes of instruction per day, 5 days per week, for each class, each year, provided, that there is in operation a program of systematic group instruction for out-of-school young farmers and for adult farmers for not less than a total of 72 clock hours during the year.<sup>2</sup>

Since the instructor in vocational agriculture cannot allocate enough time to the farm mechanics phase of the program to teach all of the abilities, those that are taught should be carefully selected. A farm mechanics course of study should therefore aid instructors in selecting the abilities most appropriate to the needs of students in a given department.

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1. U. S. Office of Education, Vocational Education Bulletin No. 1, Administration of Vocational Education, p. 39.

2. Ibid., p. 40.

Two years ago a course of study for first year students of vocational agriculture was published and is now being used by many agricultural departments in Arizona.<sup>1</sup> State supervisors and teacher trainers during systematic supervision of these departments have noted the improvement made in the instruction of first year students since this course of study has been followed. This would indicate that a comparable course of study for farm mechanics would likewise improve the farm mechanics instruction.

#### Objectives of Farm Mechanics

The major objective in farm mechanics for all-day class instruction is: To train individuals to do the unspecialized mechanical activities ordinarily done on the farm and in the farm home with the tools ordinarily available.

Cook and Walker<sup>2</sup> enlarge this objective into the following general objectives:

1. To develop abilities in repairing or constructing any equipment needed by the boy's farming program, including the farm and farm home needs.
2. To develop abilities which will help the boy as a farmer to save money.
3. To develop desirable habits, ideals, attitudes, understandings and appreciations for farm mechanics work.
4. To develop the ability to properly select farm equipment and building materials.

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1. Cline, R. W., and Schafer, W. A., Course of Study for First Year Students of Vocational Agriculture.

2. Cook, G. C., and Walker, Clyde, Practical Methods in Teaching Farm Mechanics, p. 19.

5. To develop the ideal in every farm boy to have a well equipped and orderly kept home farm shop.
6. To develop the ability to select tools, construct equipment and organize a home farm shop.
7. To develop the ideal in every farm boy to select, own, and operate efficiently farm machinery and other equipment needed on his farm.
8. To develop ability and confidence to perform needed mechanical jobs on the farm and in the farm home.
9. To develop abilities in the safe use of equipment.

It should be kept in mind that there is no suggestion made that the instructor attempt to make specialists of the students, even if he has the ability to do so. Farmers need abilities used in many trades rather than to become specialists in one or two types of work. When a job arises which requires specialized tools and/or skills, a farmer should recognize that it is usually more economical in both time and money to take this job to a specialist. His time can best be used for preventative maintenance and servicing rather than specialized repair.

#### The Teaching Situation in Farm Mechanics

There is little uniformity in farm mechanics instruction in the different departments of vocational agriculture in Arizona. The departments vary widely in the amount of time used in teaching farm mechanics, in the quantity and quality of farm mechanics facilities, the training of the instructors, and the nature and quality of the instructional procedures.

The amount of time devoted to teaching farm mechanics varies from more than 300 hours per year per class in one department, to less than

100 hours in other departments. The farm mechanics facilities vary from a well planned, attractive shop of more than 3,500 square feet in one department, adequately equipped with both power and hand tools, to departments having poorly arranged, inadequately lighted shop rooms of less than 1,500 square feet of space and with insufficient tools and equipment. The training of the instructors varies from more than thirty college hours of agricultural engineering for some instructors to twelve hours for others. The type of instruction varies from the use of accepted farm mechanics teaching procedures (including supervised study, demonstrations, practice on basic skills, and construction of real projects) to that of starting students directly on projects or farm shop jobs, with no advance preparation on the part of students.

There is also considerable variation in the experience and abilities of the students in a class. Some students have been reared on well-tooled farms and have worked with tools and machinery since childhood. Other students have been reared in town and have had very little mechanical experience of any kind.

#### Statement of the Problem

It is the purpose of this study to develop teaching units for selected areas of farm mechanics for use in the course of instruction for Arizona departments of vocational agriculture. The emphasis is on providing a workable guide for teaching the various abilities in farm mechanics. Teaching units will be developed for those areas that are most uniform in skills and content throughout the state.

### Outline of the Problem

Main problem: To determine the abilities to be taught in selected areas of farm mechanics and to organize these abilities into suitable teaching units.

Sub-problems:

1. To select the areas of farm mechanics for which teaching units should be developed.
2. To develop teaching units for the areas.
3. To select abilities to be included in each teaching unit and to arrange the abilities in proper teaching sequence.
4. To evaluate and revise the abilities and content for each teaching unit.
5. To develop a list of teaching-learning activities appropriate for teaching the abilities.
6. To compile a suggested list of jobs and projects for construction or repair in each of the areas.
7. To determine the time needed to teach each ability and each unit.
8. To compile and evaluate a list of references for each teaching unit.

### Fundamental Assumptions

In conducting this study the following assumptions are made which may be accepted as true. There is no attempt in this study to substantiate their validity.

1. Knowledges, appreciations and understandings, as well as operations, are important abilities in farm mechanics.<sup>1</sup>
2. Basic knowledges and skills should be taught in farm mechanics, as well as farm shop jobs.

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1. Cook, G. C., and Walker, Clyde, Practical Methods in Teaching Farm Mechanics, p. 186.

3. Basic knowledges and skills can best be taught by systematic analysis and instruction, rather than by teaching these skills entirely as incidental to doing farm shop jobs.
4. The doing of real, practical farm shop jobs and projects is the best method of giving additional practice and of fixing these knowledges and skills in the learner.<sup>1</sup>
5. A jury of experienced teachers of farm mechanics are capable of selecting abilities and activities for a course of study in farm mechanics and are also able to determine the approximate amount of time necessary to teach these abilities.

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1. Hammonds, Carsie, Teaching Agriculture, p. 146

## PART II

## RELATED STUDIES AND INVESTIGATIONS

## Studies Pertaining to Farm Mechanics Courses of Study

The Research Committee of the Agricultural Education Section, American Vocational Association, has summarized the studies in agricultural education in three publications<sup>1</sup> listing 1,041 studies. Among these are thirty-nine pertaining to farm mechanics courses of study. Those most closely related to this problem in subject matter or method of procedure are hereby listed:

1. Alampi, Phillip. A Farm Shop Program for the Woodstown High School Area. Thesis, M. Ed., 1945, Rutgers University. 216 pp. Library, Rutgers University, New Brunswick, N. J.

A survey blank was prepared and presented to farmers in the Woodstown area to determine the essential farm mechanics jobs or operations that should be taught to high school students. Through this survey a large number of operations and jobs were selected to be included in the farm shop program of the high school.

2. Hamilton, Edward Hudson. The Farm-Shop Needs of the Graduates and Undergraduates of the New York State School of Agriculture at

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1. The Research Committee of the Agricultural Education Section, American Vocational Association. Summaries of Studies in Agricultural Education, Vocational Education Bulletin No. 180.

Supplement No. 1 to Vocational Education Bulletin No. 180.

Supplement No. 2 to Vocational Education Bulletin No. 180.

Morrisville, New York. Thesis, M. S., 1939, Cornell University. 84 pp. Library, Cornell University, Ithaca, N. Y.

A survey of farm and non-farm groups indicated that there was more interest in repair jobs than new construction. The trend of interest seemed to be away from woodwork toward metal work, plumbing, electrical work and farm machinery repair.

3. Hansen, Clifford G. A Study of Farm Mechanics on Typical Farms in the North Cache High School District. Thesis, M. S., 1949, Utah State Agricultural College. 49 pp. Library, Utah State Agricultural College, Logan.

The purpose of the study was to determine what farm mechanics jobs farmers perform and to determine what jobs should be included in a farm mechanics course of study. The questionnaire submitted contained a comprehensive list of farm jobs and operations selected from sixteen different areas of shop work. Farmers reported that they did an average of forty six percent of the jobs and operations in: farm machinery, woodwork, farm motor mechanics, hot and cold metal, painting and glazing, electricity, power transmission, and farm engineering.

4. Hayden, Lyle Johnson. Enterprises and Objectives in Vocational Farm Mechanics. Thesis, M. S., 1931, Pennsylvania State College. 53 pp. Library, Pennsylvania State College, State College.

This study was made to determine what enterprises should be taught in farm mechanics, the amount of time required to teach each enterprise adequately, and the objectives or standards of achievement each boy should attain for each enterprise before completing the course. The findings indicate that the boy should be taught the mechanical skills

required by the problems of tomorrow, and teachings, in general, should begin with the more simple skills and correlated with projects where possible.

5. McClay, David Ross. The Place of Welding in the Farm Mechanics Program in Vocational Education in Agriculture. Thesis, M. S., 1943, Pennsylvania State College. 47 pp. Library, The Pennsylvania State College, State College.

Farmers, agriculture teachers and others that were surveyed recommended twenty hours of instruction in electric welding and twenty-two hours for oxy-acetylene welding for vocational agriculture students. All groups unanimously recommended that vocational agriculture students receive some welding instruction.

6. Speiser, Alfred T. A Three Year Farm Mechanics Course of Study for the Del Norte, Colorado, High School. Special report, M. S., 1940, Colorado State College of Agriculture and Mechanic Arts. 58 pp. Library, Colorado State College, Fort Collins.

A list of basic skills was formulated for the first year's work in farm mechanics. A job outline of important shop jobs was developed for each of the ten important farm enterprises conducted by farmers in the community.

#### State Courses of Study

Course guides in farm mechanics have been prepared in many states. The following courses of study are not based upon organized studies but have some similarity to this problem in subject matter and procedure:

1. Cain, Guy E. Four Year Course of Study for Teaching Farm

Mechanics. West Virginia State Board of Education, Division of Vocational Education, Vocational Agriculture Service, Charleston, West Virginia, 1949. 34 pp.

A suggested outline to aid teachers of farm mechanics. Eighteen areas, called phases of training, are distributed in a four year course. A time allotment in days, with suggested teacher activities, student jobs, and references are suggested for each area.

2. Cline, R. W. and Schafer, W. A., Course of Study for First Year Students of Vocational Agriculture. State Department of Vocational Education, Phoenix, 1948. 93 pp.

Although this course of study does not contain farm mechanics teaching units, other units in agriculture are analyzed, and abilities, content, teaching-learning activities, and references are suggested. The organization of abilities and teaching-learning activities in this course are suggestive of a form that may be used for farm mechanics teaching units.

3. Cranston, F. A., et al. Montana State "Course of Study" for Vocational Agricultural Education. State Board for Vocational Education, Bozeman, 1948. 58 pp.

The farm mechanics field is divided into six large teaching units, with a part of each unit taught in each of the four years of high school. Each unit contains abilities to be taught and teaching-doing activities. Content and references are not suggested.

4. Department of Agricultural Education, University of Arizona. Suggested Course of Study in Farm Mechanics for Departments of Vocational Agriculture in Arizona. State Department of Vocational Education, Phoenix, 1943. 21 pp.

In this four year course of study the farm mechanics areas are analyzed into operations, with references and number of teaching days suggested. There are also suggested shop jobs for each area. No content or teaching-learning activities were compiled.

5. Department of Agricultural Education, University of Idaho, Suggested Four Year Vocational Agriculture High School Farm Mechanics Program for Idaho. Department of Agricultural Education, University of Idaho, Moscow, 1948. 12 pp.

Farm mechanics areas are suggested for each year of high school and skills and projects are suggested for each area. No content, teaching-learning activities or references are offered.

6. Hitchcock, Sam. A Suggestive Farm Mechanics Plan Book for Vocational Agriculture Teachers. Division of Vocational Education, State Department of Education, Cheyenne, Wyoming, n. d., 96 pp.

A four year farm mechanics course of study. The farm mechanics field is divided into enterprises, with different jobs in each enterprise taught in the four years of high school. Procedures for doing each job are also listed.

7. Howey, Robert, et al. Suggestions for Organizing and Teaching Farm Mechanics in Vocational Agriculture. Agricultural Education, College of Education, University of Illinois, Urbana, 1949. 21 pp.

An outline for farm mechanics which shows units to be taught, yearly allocations, and time allotments for each unit. Each unit briefly suggests objectives, activities, projects and references.

8. Loreen, Oscar C. Basic Farm Shop Skills. The State Board for Vocational Education, Olympia, Washington, 1948. 38 pp.

Thirteen farm mechanic areas are analyzed into skills, ideals, and appreciations to be taught and the year in which each area should be taught is suggested. There are also suggestions for developing these abilities.

9. Nebraska State Department of Vocational Education. Curriculum in Vocational Agriculture for Nebraska High Schools and Veterans Training. Nebraska State Department of Vocational Education, Lincoln, 1947. 66 pp.

A four year course in vocational agriculture, including farm mechanics. Areas are analyzed into teaching units and units are further divided into topics and suggested procedures. A suggested time allotment by weeks is made for each area.

10. Schank, L. C., et al. Nevada State Course of Study for Vocational Agriculture. State Board for Vocational Education, Carson City, Nevada, 1948. 273 pp.

A four year farm mechanics course is included, with a list of farm mechanics jobs to be taught. The year and month of the year in which to teach each job and the number of days needed for teaching each job are indicated. Many jobs are analyzed into key steps and key points.

11. Utah Sub-Committee on State Course of Study for Agriculture. Utah Course of Study for Vocational Agriculture, Department of Public Instruction, State of Utah, Salt Lake City, 1948. 52 pp.

In the farm mechanics section of the course of study, sixteen areas or enterprises are analyzed into abilities. A total time allot-

ment for each area is suggested, also the number of days that each area should be taught in each of the four years of high school. Projects for each area are also suggested.

12. Wisconsin State Board of Vocational and Adult Education. A Suggested Outline for a Course in Farm Shop and Mechanics. Wisconsin State Board of Vocational and Adult Education, Madison, 1938. 18 pp.

Nineteen farm mechanics areas are outlined and some content is suggested in each area. A suggested teaching time distribution in days is offered. No abilities or teaching-learning activities are suggested.

#### Summary

Included in the literature reviewed were eighteen courses of study from fifteen different states. These courses of study served as valuable aids to the author in selecting abilities for the different areas and in developing a list of jobs and projects for each area.

Although a majority of the courses of study suggested abilities to teach in various areas of farm mechanics, none of these guides suggested the content to associate with each ability or the teaching-learning activities that may be used to teach these abilities. In the courses of study in which references were suggested, no attempt was made to evaluate the references.

It is the opinion of the author that none of the areas in the courses of study reviewed have been sufficiently developed to serve as teaching units for instruction in farm mechanics.

### PART III

#### PROCEDURE

##### Selecting Areas for the Study

Fourteen areas in the field of farm mechanics were selected for this study. They include those that are most uniform in importance, skills and content throughout the state. They are:

Arc welding

Cold metal work

Concrete and masonry work

Farm fencing

Farm pipework

Glazing

Hot metal work

Making and using drawings and plans

Oxy-acetylene welding

Painting

Rope work

Selecting lumber and hardware

Soldering and sheet metal work

Tool conditioning and handle fitting

Omitted from this study are such areas as farm plumbing, farm electricity, truck and tractor repair, and construction and repair of farm buildings. There has been little systematic teaching in these

areas and consequently there is considerable disagreement among teachers of vocational agriculture and others as to the abilities, content and jobs that should be included in these areas.

### Formulating the Teaching Units

Teaching units for each of the fourteen areas were formulated after a comprehensive review of literature related to the problem. Included in the literature were Master's theses on farm mechanics courses of study, farm mechanics textbooks, articles in professional magazines, and eighteen courses of study from fifteen different states. These materials served as valuable aids in analyzing the units, selecting references, and selecting projects for construction and repair.

Each area was first analyzed into abilities peculiar to that area, and stated in terms of skills, knowledges, and appreciations. The word, "ability", as used throughout this study, is interpreted to mean "the capacity to perform". Content or information was then associated with each ability in order to clarify, add meaning, or suggest minor activities. These abilities were then arranged in proper teaching sequence as determined from the difficulty of the abilities, the necessity for knowledge of other skills, and the importance of the ability.

### Developing a List of Teaching-Learning Activities

Teaching-learning activities were suggested for as many of the abilities as possible. These activities on the part of the teacher or the student (other than reading, class discussion, or note taking)

are to further the development of the desired abilities on the part of the learner. From the standpoint of the teacher, teacher demonstration of the skills to be learned is the most important of the teaching-learning activities. More teaching-learning activities were listed in a unit than time would allow an instructor to use. They are only a list of suggestions in a convenient place for the use of the teacher.

#### Compiling a List of Jobs and Projects

A list of construction and repair projects and jobs was then compiled for each teaching unit. This list was restricted to practical farm jobs and projects which are commonly done on Arizona farms and ranches. In some areas these suggested jobs are almost exclusively repair work. Soldering and sheet metal is an example of such an area. The average farmer has neither the skills nor the tools to construct such sheet metal devices as buckets, tubs, chick feeders, and poultry watering devices. In most cases these devices can be purchased more cheaply and are better in appearance and quality than those constructed by the farmer. However, these devices can be repaired and made usable through the use of minor skills and minimum tools and equipment.

#### Compiling a List of References

References were compiled for each teaching unit and were listed at the end of the unit. These references were selected from farm mechanics courses of study and from a bibliography of selected references for departments of vocational agriculture.<sup>1</sup> Certain references listed

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1. Department of Agricultural Education, University of Arizona, Bibliography of Reference Books for Departments of Vocational Agriculture.

as "Teacher References" are either too technical for high school students, or are not available in sufficient quantities for student use.

The criteria used for selecting references are:

1. Is the content accurate and up-to-date?
2. Is it procurable in quantities adequate for class use?
3. Is the information presented in a clear, concise form?
4. Are the abilities and information presented adapted to the needs of farmers?
5. Is the content organized around appropriate teaching units?
6. Is the publication well illustrated with the illustrations clear, accurate, and appropriate to the skill or area in which they are used?

#### Evaluating the Teaching Units

Nine vocational agriculture teachers in Arizona departments of vocational agriculture were selected to evaluate certain phases of the teaching units. These judges were selected on the basis of years of teaching experience, knowledge of farming situations in the community, training in farm mechanics work, and quality of the farm mechanics program in the high school. The information for determining the years of teaching experience and the farm mechanics training of these teachers is found in records in the files of the Agricultural Education Department of the University of Arizona. Information relative to each teacher's knowledge of farming situations in his community and the quality of the

farm mechanics program in the high school was obtained in conferences with state supervisors and teacher trainers of vocational education in agriculture.

The farm mechanics teaching units were presented to these judges as a group. Afterwards each teacher was interviewed individually. The judges were asked to evaluate the abilities and the references that were suggested in each unit, to indicate the time needed to teach each ability, and to determine the total time needed to teach each unit.

The following instructions were given to the judges:

#### Importance of Ability

1. Rate each ability as to its importance, using the following rating scale:
  - E - Essential: must be included in the teaching unit.
  - I - Important: should be taught if time will permit.
  - U - Unimportant: should be eliminated from the unit.
2. Place the appropriate letter (E, I, or U) on the left-hand side of each ability suggested.
3. Add any abilities that you think have been omitted.
4. Circle any content associated with an ability if you think it should be omitted.

#### Hours Needed to Teach the Abilities in Each Unit

1. Determine the number of hours or fractions of hours you think will be needed to teach each ability.
2. Place this number on the right-hand side of the ability.
3. Add the hours and fraction of hours needed to teach each ability in the unit and insert the total in the

blank at the top of the first page.

#### Value of References

1. Circle any references you think should be omitted.
2. Add any references you think should be included.

#### Revising and Completing the Units

On the basis of the combined evaluation of the instructors, the teaching units were revised, using the following guide:

1. Any ability and its associated content will be omitted from the unit if fifty percent or more of the judges consider the ability unimportant. (Fifty percent is an arbitrary figure and was selected because this figure has been commonly used in other investigations comparable to this study.)
2. Any ability will be added to the unit if three or more judges consider it important or essential.
3. Any reference will be omitted from the unit if fifty percent or more of the judges indicate that it should be omitted.
4. A reference will be added to the list if two or more judges indicate that it should be added.

The time allotment suggested for each unit of this study was determined by finding the central tendency of the time allotments suggested by the judges. The median was used as the measure of central tendency. Those medians that were in hours and fractions of an hour were each changed to the nearest whole number, and a whole number was

used in the suggested number of hours for teaching each unit developed in this study. For example: The median of the time estimated by the judges for teaching the unit on painting is eleven and one-quarter hours, so eleven hours are suggested for teaching the unit on painting developed in this study. See Table 2.

## PART IV

## FINDINGS AND APPLICATION OF DATA

## Results of Evaluations

On the basis of the evaluations offered by the judges, (see the instructions to judges in the section, Evaluating the Teaching Units, PART III) several abilities and their associated content were omitted from the revised teaching units. Table 1. lists the abilities that

Table 1.

Abilities Eliminated from Original Teaching Units By  
Fifty Percent or More of Nine Judges

Abilities eliminated from different units	Number of judges eliminating the ability
Concrete and Masonry Work	
Run concrete in cold weather	6
Make colored concrete	4*
Farm Pipework	
Cut a gasket for a union	5
Repair pumps	4*
Oxy-Acetylene Welding	
Drain and re-clean an acetylene generator	5
Painting	
Finishing a knotty pine room	4*
Stain shingles	4*
Refinish furniture	5
Mix paint at home	5
Rope Work	
Understand and use common rope work terms	5
Soldering and Sheet Metal Work	
Do special sheet metal operations requiring special tools	5
Tool Conditioning	
Sharpen lawn mowers	5
Sharpen wood burnishers or scrapers	5
Sharpen crosscut timber saws	4*
Sharpen circular saws	4*

\*Only eight judges evaluated these abilities.

were eliminated from the original teaching units and gives the number of judges who voted to eliminate each ability. None of the judges suggested any abilities to add to the units. This was as expected because an effort was made by the author to incorporate as many abilities in the original teaching units as possible.

Table 2. shows the amount of time in hours each teacher considered necessary to teach each unit, the medians of these time evaluations, and the nearest whole hour to each of these medians. The wide variations in hours estimated by different teachers for teaching the units are probably the result of variations in the training of the teachers and variations in teaching methods used by different teachers. This wide variation is also apparent in a survey by Young<sup>1</sup> of the instruction offered in farm mechanics by forty teachers of vocational agriculture in Illinois. This survey showed a variation of from one to sixty hours used by different teachers to teach the area of cold metal work. The variations in teaching time for other areas were almost as wide.

In evaluating the references included in each teaching unit, no references were eliminated by the judges but three references were suggested to be added to the revised teaching units. These references are:

Berg, Edward. Mechanical Drawing. The Bruce Publishing Company, Milwaukee.

Giese, Henry. A Practical Course in Concrete. Portland Cement Association, Chicago 10, Illinois.

The Linde Air Products Company, How to Bronze Weld. The Linde Air Products Company, New York.

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1. Young, Orville L., Teacher Education, Illinois State Normal. An unpublished survey, no title, 1950. 12 pp.

Table 2.

## Evaluation of Time Needed to Teach Each Farm Mechanics Unit\*

Teaching units	Teaching time in hours									Median time	Nearest whole hour
	1	2	3	4	Judges:	6	7	8	9		
Arc Welding	7.0	9.5	54.0	10.5	31.0	15.0	15.75	20.75	3.25	15.0	15
Cold Metal Work	2.0	5.25	18.5	10.0	20.0	10.25	8.25	9.25	3.0	9.25	9
Concrete and Masonry Work	4.0	10.0	30.0	13.5	31.0	9.75	10.25	7.75	3.25	10.0	10
Farm Fencing	1.5	4.0	12.0	5.0	9.5	6.0	4.5	5.5	1.75	5.5	6
Farm Pipework	3.75	9.25	29.0	11.5	17.25	12.25	7.5	10.0	2.25	10.0	10
Glazing	2.0	3.25	6.0	5.5	6.5	3.5	3.0	5.75	2.5	3.5	4
Hot Metal Work	5.0	5.5	14.25	5.25	16.0	8.5	7.5	10.75	4.25	7.5	8
Making and Using Drawings & Plans	7.25	4.25	38.0	11.0	21.5	10.25	4.75	12.5	3.75	10.25	10
Oxy-Acetylene Welding	12.5	8.0	33.0	12.0	34.5	17.75	19.0	20.75	4.0	17.75	18
Painting	5.25	8.5	39.5	12.0	35.5	10.25	13.25	11.25	5.5	11.25	11
Rope Work	6.75	3.5	8.5	6.25	11.5	3.0	1.5	7.75	1.75	6.25	6
Selecting Lumber and Hardware	2.75	8.0	13.0	4.75	15.5	5.5	5.0	4.0	3.0	5.0	5
Soldering and Sheet Metal Work	4.25	8.5	8.0	9.25	16.75	12.25	9.0	10.0	4.25	9.0	9
Tool Conditioning & Handle Fitting	7.5	5.0	34.0	9.25	23.0	12.0	10.5	7.5	5.0	9.25	9

\*Evaluation made by nine Arizona teachers of vocational agriculture.

## The Teaching Units

Teaching units were developed for fourteen areas of farm mechanics. The original teaching units were then revised on the basis of evaluations offered by the judges and are hereby presented in alphabetical order. This order should not be interpreted to be the order in which the units should be taught.

For purposes of clarification, the terms, "area of farm mechanics" and "teaching unit", as they are used in this study, are defined.

An area of farm mechanics is a natural division of farm shopwork in which the abilities and information are related and in which common tools are used in the performance of the different skills and jobs.

A teaching unit is a division of subject matter within an area containing closely related abilities and information capable of being efficiently learned. A teaching unit may be used by the instructor to suggest abilities and information that may be learned and procedures, activities and aids that may be used in the instruction.

The following form is used for each teaching unit: The abilities to be learned are listed in a column on the left hand side of the page and are preceded by capital letters. Suggested teaching-learning activities are listed in a column on the right hand side of the page and are located directly opposite the abilities to which they refer. References for study are listed at the end of each unit.

Teaching Unit: Arc Welding

Hours: 15

Ability to:	Suggested Teaching-Learning Activities
A. Appreciate the advantages and characteristics of arc welding on the farm.	
1. What arc welding is and how it operates	
2. Jobs that can be done by arc welding	
3. Metals most commonly welded	
4. Cost of equipment and supplies	
B. Recognize dangers and use precautions in welding.	Demonstrate safety precautions.
1. Burns: eye burn, sun burn, splattering metal, handling hot metal	
2. Shock: uninsulated electrode holder handle	
3. Safety methods: shields, clothing, eliminating inflammable materials, etc.	
C. Select equipment and supplies.	Place all equipment and materials where students can see and handle during discussion.
1. AC transformer welders: manufacturers, sizes, costs, advantages and disadvantages	
2. AC-DC generator welders: sizes, costs, advantages and disadvantages	
3. Gasoline-driven DC generator welders: sizes, costs, advantages and disadvantages	
4. Rods: kinds, sizes, costs, uses, identifying	Show the identifying marks on different kinds of rods.

## Arc Welding (continued)

Ability to:	Suggested Teaching-Learning Activities
5. Equipment: kinds and costs of gloves, welding tables, cables, ground clamps, electrode holders, shields, colored and clear lens, arc torch	Show how to replace lens in a shield.
D. Hook up and adjust welder and equipment. <ol style="list-style-type: none"> <li>1. Plugging in welder</li> <li>2. Making good ground connections</li> <li>3. Switching on welder and adjusting controls               <ol style="list-style-type: none"> <li>a. Amperage</li> <li>b. Voltage (unless automatic)</li> </ol> </li> </ol>	
E. Strike an arc and run a bead. <ol style="list-style-type: none"> <li>1. Proper size and kind of rod</li> <li>2. Methods of striking an arc</li> <li>3. Running a bead               <ol style="list-style-type: none"> <li>a. Length of arc</li> <li>b. Angle of electrode</li> <li>c. Speed of travel</li> <li>d. Current setting for thickness of metal</li> </ol> </li> </ol>	After demonstrating and trying out one or more students, use students to try out other students.
F. Recognize or know a good weld. <ol style="list-style-type: none"> <li>1. Characteristics of welds as to:               <ol style="list-style-type: none"> <li>a. Appearance of bead</li> <li>b. Amount of bend weld will take</li> <li>c. Appearance of broken weld</li> </ol> </li> </ol>	Break welds in vise and show students failures caused by insufficient penetration, slag inclusions, burned metal, etc. (A weld should bend 90° without breaking.)

## Arc Welding (continued)

Ability to:	Suggested Teaching-Learning Activities
G. Weld wrought iron and mild steel	<p>For uniformity, use 2" x 5" pieces of mild steel for butt, T and lap welds, Grade each weld after inspecting and testing.</p> <p>Demonstrate approved welding practices in accordance with items under G thru M in this unit.</p>
1. Preparing metal: cleaning, grooving	
2. Spacing metal and holding in position	
3. Tacking joints	
4. Making thin butt joints	
5. Making thick butt joints: single and double V	
6. Building up or padding metal	
7. Making Tee joints or fillet welds	
H. Weld cast iron	<p>Test cast iron welds by striking with a hammer. (The piece should break at the side of the weld, not in the weld.)</p>
1. Preparing material	
2. Preventing cracking	
a. Short beads, then cooling	
b. Preheating	
c. Cooling slowly	
3. Welding: short arc and low current	
I. Weld high-carbon steels	<p>Nick and cut hard surface deposits to compare with the hardness of mild steel surfaces.</p>
1. Preheating	
2. Welding with proper rod and current	
3. Annealing	
4. Cooling slowly	

## Arc Welding (continued)

Ability to:	Suggested Teaching-Learning Activities
J. Hard surface metal	
1. Using low current	
2. Depositing metal	
K. Cut and make holes in metal	
1. Amount of amperage and size of rod	
2. Method of cutting	
L. Weld in different positions	
1. Horizontally	
2. Vertically	
3. Over head	
M. Use a carbon arc torch	
1. Heating metal	
2. Welding copper or brass	
3. Brazing mild steel or cast iron	
N. Construct and repair welding projects in the school and farm shops	After learning the basic skills, each student do one or more welding projects. These should be practical farm jobs to be used if possible on the students home farm.
1. Make: Welding table, chipping hammer, saw horse, electrode stand, trailer hitch, clothes line poles, iron rack, milking stool, welding stool, homemade anvil, soil moisture probe, gopher probe.	
2. Repair: Broken chains, broken casting, bumper, hoes, shovels, holes in tanks and barrels, cylinder heads, frames for different machines, gear teeth, plow discs, fenders.	

## Arc Welding (continued)

## References:

1. Kugler, Harold L., Arc Welding Lessons for School and Farm Shop.
2. Smith, Robert E., Units in Forging and Welding.
3. Jones, Mack M., Shopwork on the Farm.
4. Cook, G. C., Scranton, L. L., and McColly, H. F., Farm Mechanics Text and Handbook.

## Teacher references:

1. Procedure Handbook of Arc Welding Design and Practice, The Lincoln Electric Company.
2. Welding Helps for Farmers, The James F. Lincoln Arc Welding Foundation.

Teaching Unit: Cold Metal Work

Hours: 9

Ability to:	Suggested Teaching-Learning Activities
<p>A. Identify and know the characteristics of common metals such as mild steel, high carbon and tool steel, cast iron, aluminum, copper and brass</p>	
<p>1. Identifying by sparks, color, weight, shape, ease of fracturing, sound, etc.</p>	<p>Show the differences between each of these metals in accordance with items under A 1 and 2.</p>
<p>2. Characteristics of these metals as to strength, brittleness, wear resistance, hardness, ease of cutting, cost, etc.</p>	
<p>3. Alloy steels: metals added to steel and the properties they give it</p>	
<p>4. Uses of the metals for farm equipment and tools</p>	<p>Students identify kinds of metal in all metal objects in the school shop and common pieces of farm equipment.</p>
<p>a. Low carbon, including mild steel and wrought iron: pipe, angle iron, boiler plate, chains, bolts, roofing, milk pails and cans, etc.</p>	
<p>b. High carbon and tool steel: discs, hayrake teeth, files, chisels, punches, springs, axles, etc.</p>	
<p>c. Cast iron: cast iron pipe, pump housings, mower wheels, engine blocks and heads, pipe fittings (malleable iron)</p>	
<p>d. Aluminum: lightweight castings, roofing, kettles, engine heads, pistons, light reflectors, milk cans and pails, cooling coils</p>	
<p>e. Copper and brass: pipe, tubing, bushings, kettles, etc.</p>	

## Cold Metal Work (continued)

Ability to:	Suggested Teaching-Learning Activities
<p>B. Measure and mark metal</p> <ol style="list-style-type: none"> <li>1. Using different measuring devices</li> <li>2. Using awl, scribe and prick punch</li> </ol>	
<p>C. Bend mild steel</p> <ol style="list-style-type: none"> <li>1. With hammer and anvil</li> <li>2. In a vise</li> <li>3. Using piece of pipe</li> </ol>	<p>Demonstrate all metal working skills and try out at least one learner on each skill.</p>
<p>D. Cut cold metal to length and shape</p> <ol style="list-style-type: none"> <li>1. Using chisel: shearing thin bars and sheets, cutting thick bars and round stock in the vise and on the anvil</li> <li>2. Using hardy and/or cold cutter</li> <li>3. Using slitting chisel</li> <li>4. Cutting slots and grooves</li> <li>5. Using hacksaw: type and sizes of hacksaws and blades, choosing blade and putting in frame, starting cut, holding saw, speed of sawing, holding the work.</li> <li>6. Using bolt cutters and clippers</li> <li>7. Cutting tool steel: using hacksaw, chisel or hardy.</li> <li>8. Cutting slots: drilling holes, cutting between with hacksaw</li> </ol>	<p>Show how to insert blade and tighten in frame. Show how number of teeth per inch affects the job to be done.</p>

## Cold Metal Work (continued)

Ability to:	Suggested Teaching-Learning Activities
E. Punch holes in metal	
1. Using solid punch	
2. Using hollow punch	
F. Drill holes in metal	
1. Selecting drilling equipment: electric drill, drill press, hand drill, breast drill	Have students practice on scrap pieces. Use uniform class exercises on each major skill to check student per- formance.
2. Locating hole and marking	
3. Counter sinking	
4. Choosing proper size and type of drill bit for the work and for the drill and chuck used.	
5. Holding metal while drilling: methods, safety precautions	Show how to prevent injury while drilling short pieces.
6. Drilling metal: speed, pressure, using coolant and lubricant, pre- cautions	
7. Drilling holes in round rod or pipe	
8. Drilling holes in thin metal	
9. Drilling extra large holes	
G. Rivet metal	
1. Selecting rivets: size, type, and length	
2. Drilling proper size holes	
3. Riveting: upsetting, forming head	

## Cold Metal Work (continued)

Ability to:	Suggested Teaching-Learning Activities
H. Select, care for, and use files effectively	Show several different kinds, sizes, and types of files and demonstrate how each is used. Have students select files for a particular job and give complete description of the file selected.
1. Classifying files	
a. Shape, style or use: mill, flat, round, half round, etc.	
b. Size of file	
c. Kind of teeth: single cut, double cut, rasp	
d. Cut of teeth: coarse, bastard, second cut, etc.	
2. Caring for files: storing, cleaning, keeping files clean	
3. Holding the file: position of hand and body, holding the material, using handles	
4. Using the file	
a. Speed and pressure of strokes and backstrokes	
5. Filing a surface flat and true	Demonstrate how to do special filing jobs. Each student use files to dress metal working projects.
6. Drawfiling	
7. Filing soft metal	
8. Filing cast iron	
I. Thread bolts and nuts	Demonstrate cutting threads. Use the eye bolt made in hot metal work.
1. Making a bolt	
a. Selecting rod: size, length, material	
b. Selecting the proper kind and size of die	

## Cold Metal Work (continued)

Ability to:	Suggested Teaching-Learning Activities
<ul style="list-style-type: none"> <li>c. Tapering the rod</li> <li>d. Threading the rod: holding rod, starting die, lubricating, unclogging, removing die</li> <li>e. Cleaning die</li> </ul>	
<ul style="list-style-type: none"> <li>2. Making a nut               <ul style="list-style-type: none"> <li>a. Selecting tap: size, kind of thread</li> <li>b. Selecting metal for nut: length and width, thickness</li> <li>c. Drilling proper size hole</li> <li>d. Tapping threads: holding nut, starting tap, unclogging, removing tap</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>3. Reconditioning damaged bolts and nuts</li> </ul>	Each student recondition two or more bolts and nuts.
<ul style="list-style-type: none"> <li>4. Tapping threads in a blind hole using taper, plug and bottoming taps</li> </ul>	Demonstrate removing bolt broken off flush with threaded surface.
<ul style="list-style-type: none"> <li>J. Countersink and counterbore metal.</li> </ul>	
<ul style="list-style-type: none"> <li>K. Ream holes in metal.</li> </ul>	
<ul style="list-style-type: none"> <li>L. Construct cold metal projects in the school shop and on the farm.</li> </ul>	After acquiring the basic cold metal skills, each student make or repair one or more cold metal projects.
<ul style="list-style-type: none"> <li>1. Make: Foot scraper, gate hinges, bolts, eye bolts, iron braces, shelf brackets, welding stool, trailer hitch pin, hammer and axe wedges</li> </ul>	
<ul style="list-style-type: none"> <li>2. Recondition and/or repair: Bolts and nuts, screw drivers, pieces of farm machinery, trailers</li> </ul>	

## Cold Metal Work (continued)

## References:

1. Cook, G. C., Scranton, L. L., and McColly, H. F., Farm Mechanics Text and Handbook.
2. Jones, Mack M., Shopwork On the Farm
3. Henderson, M., and Rucker, H. J., Cold Metal Work. A mimeographed publication from the College of Education, University of Illinois.

Teaching Unit: Concrete and Masonry Work

Hours: 10

Ability to:	Suggested Teaching-Learning Activities
A. Know the ingredients and characteristics of concrete.	
1. Advantages of concrete	
a. Permanency	
b. Sanitary	
c. Rodent proof	
d. Fire resistant	
e. Simple upkeep	
2. What concrete is: materials, methods of manufacture	
3. Portland cement: composition, how it is made, hardening and setting action	
4. Special types of cement: white, high-early-strength, low heat, etc.	Show different kinds of cement. (Department should have samples of cement, sand, and gravel for class use.)
5. Aggregates: fine, coarse, bank-run gravel	
6. Essentials for making good concrete	
a. Clean, properly graded aggregates	
b. Proper water - cement ratio	
c. Proper mixing and plasticity	
d. Proper placing methods	
e. Proper temperature	
f. Proper forming and reinforcing	
g. Proper curing	

## Concrete and Masonry Work (continued)

Ability to:	Suggested Teaching-Learning Activities
B. Select suitable ingredients	Grade some sand and bank-run gravel to determine the fineness modulation. Demonstrate silt and organic matter tests.  Demonstrate how to wash silt out of sand.
1. Sand or fine aggregate	
a. Size, grading, cleanliness	
b. Testing for silt	
c. Testing for organic matter	
d. Washing aggregates	
2. Coarse aggregate	
a. Size, gradation, cleanliness, hardness	
3. Water: cleanliness, alkalinity	
C. Determine proportions of materials to use.	
1. The water - cement ratio strength law	
2. Quantity of paste for specific purposes	
a. 5-gallon paste: strength and use	
b. 6-gallon paste: strength and use	
c. 7-gallon paste: strength and use	
3. Proportioning water in different mixes to allow for the water in sand	
a. Damp sand containing from 1/2 to 3/4 gal. water per cu. ft.	
b. Wet sand containing from 1 to 1-1/2 gal. water per cu. ft.	

## Concrete and Masonry Work (continued)

Ability to:	Suggested Teaching-Learning Activities
c. Very wet sand containing from 1-1/4 to 2-1/2 gal. water per cu. ft.	
4. Workability or plasticity of a good mix	
5. Suggested amount of ingredients for different pastes and different kinds of work	
6. Making trial mixes	Make slump test on several batches of cement.
7. Correcting trial mixes	
8. Proportioning for economy	
9. Taking slump tests: method, interpreting test	
D. Estimate quantities of ingredients needed.	Have students calculate the amount of ingredients for a sidewalk, garage floor, or feeding floor.
1. Determining volume of concrete needed	
2. Determining mix to use	
3. Determining amount of each ingredient	
E. Mix concrete by hand	Demonstrate the proper method of mixing while doing a concrete job.
1. Tools and methods	
2. Measuring and spreading sand	
3. Measuring and spreading cement	
4. Mixing	
5. Measuring gravel and mixing	Construct a one foot, square, open bottom measuring box.
6. Measuring water and mixing	

## Concrete and Masonry Work (continued)

Ability to:	Suggested Teaching-Learning Activities
F. Mix concrete with mixer.	
1. Speed of mixer	
2. Optimum mixing time	
3. Method of measuring and adding water, gravel, sand, and cement	
G. Purchase ready-mix concrete.	
1. Cost vs. home mix	
2. Ordering or placing order	
3. Determining amount needed	
H. Place, spade and tamp concrete.	
1. Maximum time to place concrete	
2. Preventing segregation	
3. Removing voids and compacting: spading, tamping, vibrating	
4. Placing in layers in deep forms	
5. Running complete form before concrete dries	
I. Tie new concrete to old.	
1. Roughening surface of old	
2. Leaving reinforcing rods exposed	
3. Cleaning and wetting old concrete	
4. Using thin concrete or grout between	
J. Finish concrete.	
1. Striking off or leveling: using screed, filling holes	Plan, prepare base, form, run concrete and finish a sidewalk on school ground or farm.

## Concrete and Masonry Work (continued)

Ability to:	Suggested Teaching-Learning Activities
2. Using edger	
3. Floating after water disappears	Visit construction jobs where various types of concrete finishes are being used.
4. Using groover or marker to block off	
5. Using steel trowel	
K. Cure concrete	Show by graphs and tables the effects of curing on the strength of concrete and the effects of water on the curing speed of cement.
1. Effects of proper curing on strength	
2. Curing time: optimum and practical	
3. Methods of curing: watering frequently, wet sacks, wet sand, ponding, applying wax	
4. How temperature affects curing	
L. Reinforce concrete	Show reinforcing materials.
1. Concrete jobs requiring reinforcing	
2. Materials for reinforcing	
3. Proper placing of reinforcing	
M. Provide a good base for concrete walks and floors	
1. Materials for bases: damp sand, gravel, compacted earth, etc.	
2. Compacting the base: soaking, tamping	
N. Forming concrete	
1. Characteristics of good forms: tight, correct size and shape, rigid, etc.	Construct forms for small jobs such as posts, steps, etc.

Ability to:	Suggested Teaching-Learning Activities
2. Materials to use for forms	
3. Oiling forms	
4. Bracing forms	
5. Care in filling forms	
6. Removing forms	
O. Make water-tight concrete	
1. Proper mixing and proportioning	
2. Freedom from cracks and construction joints	
3. Preventing segregation of particles	
4. Proper curing	
P. Make colored concrete	
1. Coloring pigments to use	
2. Mixing pigments	Make some stepping stones and color by the dust-on method.
3. Placing and finishing	
4. Dust-on colored topping	
5. Caring for colored floors	
6. Acid staining concrete floors	
Q. Lay masonry walls	Visit construction job to observe methods of laying masonry walls. Plan and build a small patio wall.
1. Sizes of blocks and bricks	
2. Thickness of mortar joints	
3. Proportioning and mixing mortar	
4. Method of handling mortar	
5. Laying a wall	
a. Setting and plumbing corner blocks	

## Concrete and Masonry Work (continued)

Ability to:	Suggested Teaching-Learning Activities
b. Stretching chalk line	
c. Laying blocks between corners	
d. Pointing joints	
e. Using jam blocks around openings	
f. Fastening door and window frames to wall	
R. Construct concrete and masonry projects in the school shop and on the farm:	Each student make or repair one or more concrete projects.
Anvil base, milking floor, sidewalks, salt box, chicken house floor, stock tanks, patio wall, barbecue pit, feed trough, fence posts, flower box, cement steps, set posts in concrete	

## References:

1. Cook, G. C., Scranton, L. L., and McColly, H. F., Farm Shop Text and Handbook.
2. Giese, Henry, A Practical Course in Concrete.
3. Jones, Mack M., Shopwork on the Farm.
4. Portland Cement Association, Permanent Farm Construction.
5. U.S.D.A., Farmers Bul. No. 1772, Use of Concrete on the Farm.

Teaching Unit: Farm Fencing

Hours: 6

Ability to:	Suggested Teaching-Learning Activities
A. Select fencing for farm use.	
1. What constitutes a legal fence	
2. Barb wire	Visit a supply store to study kinds of fencing and posts, cost of fencing, and kinds of electric controllers.
a. Gage of wire and number of barbs	
b. Rolls of wire needed for a certain length of 3 or 4 wire fence	
3. Woven wire fence	
a. Gage of wire and height of fence for different purposes	
4. Fence posts	
a. Wood: kinds of posts and life of each	
b. Steel posts: kinds and lengths	
c. Corner and brace posts: cement, wood, pipe, etc.	
5. Electric fence controllers	Plan and erect a barb wire fence, from setting of corner posts to stretching and fastening wire.
a. Source and type of electricity	
b. Amperage, voltage and safety features	
B. Locate and erect corner and brace posts	
1. Methods of locating, setting, and tamping	
2. Methods of bracing for strength	Illustrate on blackboard the effects of tension on the different types of braces.
a. Distance of brace posts from corner	

## Farm Fencing (continued)

Ability to:	Suggested Teaching-Learning Activities
<ul style="list-style-type: none"> <li>b. Locating braces on posts</li> <li>c. Anchors, guy wires and other devices</li> </ul>	
C. Locate and erect line posts	
<ul style="list-style-type: none"> <li>1. Methods of locating in straight line</li> <li>2. Methods of setting or driving wood and steel posts</li> <li>3. Distance apart for posts</li> </ul>	
D. Erect barb wire fences	
<ul style="list-style-type: none"> <li>1. Methods of unrolling and stringing wire along fence</li> <li>2. Methods of stretching wire</li> <li>3. Fastening wire to posts <ul style="list-style-type: none"> <li>a. Corner posts</li> <li>b. Line posts: steel, wooden</li> </ul> </li> <li>4. Putting on stays</li> </ul>	
E. Erect and operate electric fences	Observe electric fence installation, studying method of grounding, installing insulators, etc.
<ul style="list-style-type: none"> <li>1. Locating, installing and grounding the controller</li> <li>2. Installing posts: type, distance apart</li> <li>3. Fastening and installing insulators</li> <li>4. Fastening and splicing wires</li> <li>5. Making gates for electric fences</li> </ul>	

## Farm Fencing (continued)

Ability to:	Suggested Teaching-Learning Activities
G. Provide gates	Show drawings of several types of gates and analyze their advantages and disadvantages.
1. Types of gates	
2. Locating and hanging gates	
3. Providing cattle guards	
H. Repair and maintain fences	Demonstrate how to splice and tighten a broken wire in the middle of a run.
1. Re-stretching	Students repair fences on home farm.
2. Splicing broken wires	
I. Treating fence posts	
1. Posts that do not need treating	Show treating materials and treating methods
2. Methods of treating short-lived posts	
a. Creosote	
b. Pentachlorophenol	
c. Other treatments	
J. Plan a fencing project and determine the cost	Each student plan a fencing project for a piece of land and figure bill of materials and total costs.

## References:

1. Farm Fencing, Keystone Steel and Wire Co., Pittsburg, Pa.
2. Glese, Henry, Farm Fence Handbook.
3. How to Build and Erect Your Electric Fence, The Prime Manufacturing Company, Milwaukee, Wisconsin.
4. U.S.D.A., Farmers Bul. No. 1832, Farm Fences.

Teaching Unit: Farm Pipework

Hours: 10

Ability to:	Suggested Teaching-Learning Activities
A. Know pipe tools and their uses.	
1. Wrenches: types and sizes	Use plumbing shop and tool catalogues to familiarize students with different types of tools than those available in the school shop.
2. Pipe cutters: types and sizes	
3. Reamers: types and sizes	
4. Pipe dies: types and sizes, methods of changing dies and adjusting	
5. Pipe vises: chain and hinged yokes	
B. Know the different kinds of pipe and their uses.	
1. How the diameter of pipe is measured: iron pipe, tubing	Take students to plumbing shop to study the different kinds of pipe and fittings.
2. Black wrought iron pipe: sizes, uses	
3. Galvanized wrought iron pipe: sizes, uses	
4. Cast iron pipe: sizes, uses	
5. Copper pipe and tubing: sizes, uses	
C. Know the different pipe fittings and their uses.	
1. Malleable iron fittings: standard and heavy duty, black and galvanized, Tees, 45° ells, 90° ells, street ells, couplings, gate valves, globe valves, close nipples, shoulder nipples, etc.	After study and discussion, put 20 or more fittings on numbered squares for students to identify and determine sizes.
2. Cast iron fittings	
3. Copper pipe fittings	
	Take trip to a job to observe a variety of pipe fittings being used.

## Farm Pipework (continued)

Ability to:	Suggested Teaching-Learning Activities
4. Copper tubing fittings	
a. Compression type	
b. Flange or flare type	
D. Thread wrought iron pipe	
1. Holding pipe: methods	Each student make nipples, using different methods and different tools.
2. Cutting: pipe cutter, hack saw	
3. Reaming: reamer, file	
4. Threading	
a. Selecting dies and guide, installing and adjusting	
b. Starting dies	
c. Lubricating	
d. Finishing threading: length of threads, removing die	
E. Install fittings on copper pipe	Each student sweat a copper pipe fitting on a pipe. This may be done, if desirable, while working at soldering and sheet metal work.
1. Cutting pipe	
2. Cleaning pipe and fitting	
3. Using flux	
4. Heating pipe and fitting: blow torch, acetylene torch, etc.	
5. Soldering or sweating the joint	
F. Install fittings on copper tubing.	Provide water facilities and misc. fittings for testing all installed fittings and pipe runs for leaks. Have student make water pressure test when work is ready for teacher to grade or check.
1. Cutting tubing: hack saw, tubing cutter	
2. Flaring for flare fittings	

## Farm Pipework (continued)

Ability to:	Suggested Teaching-Learning Activities
3. Putting on compression fittings	
G. Assemble pipe and pipe fittings.	
1. Determining fittings to use and where to use them	Allowing for fittings and threads, each student find the exact lengths of pipe for a specified pipe run.
2. Determining the length of pipes necessary	
3. Measure, cut and thread pipe to proper length	
4. Tightening fittings: how tight to tighten, using threading compounds	
H. Straighten and bend pipe.	
1. Using hickey or pipe bender	
2. Using vise	
3. Preventing pipe from collapsing	
I. Make simple pipe and plumbing repairs.	Encourage students to bring leaky fittings and devices to school shop to repair, and to repair others at home.
1. Repairing leaky faucets and valves: washers, seats, stem packing	
2. Repairing leaky garden hose: replacing hose washers, replacing male and female fittings, stopping leak in hose	
3. Thawing pipes: procedure	
4. Repairing automatic float valves	
5. Adjusting and repairing toilet bulb and valves	
6. Unclogging pipes and fittings	

## Farm Pipework (continued)

Ability to:	Suggested Teaching-Learning Activities
J. Make a short nipple.	On project visits, help students locate shop projects to do or repair.
<ol style="list-style-type: none"> <li>1. Tools to use</li> <li>2. Method</li> </ol>	
K. Replace sections of broken pipe.	
<ol style="list-style-type: none"> <li>1. Removing old pipe</li> <li>2. Replacing new pipe and union</li> </ol>	
L. Repair a piece of leaky pipe.	
<ol style="list-style-type: none"> <li>1. By welding, using wire and solder, other methods.</li> </ol>	
M. Service an automatic water system.	On a field trip to an automatic water system, perform each of these operations.
<ol style="list-style-type: none"> <li>1. Lubricating pump and motor</li> </ol>	
<ol style="list-style-type: none"> <li>2. Tightening the stuffing box</li> </ol>	
<ol style="list-style-type: none"> <li>3. Adjusting air-intake valve</li> </ol>	
<ol style="list-style-type: none"> <li>4. Adjusting the belt tension</li> </ol>	
N. Do pipe fitting and simple plumbing projects in the school shop and on the home farm.	Each student do at least one or more pipe fitting jobs or simple plumbing projects.
<ol style="list-style-type: none"> <li>1. Make or do: Shoulder nipple, pipe bender, replace faucet, service automatic water system, replace tubing on tractor or truck fuel system, lay a water line to garden or poultry pen</li> </ol>	
<ol style="list-style-type: none"> <li>2. Repair: Leaky faucet, garden hose, automatic float valve, straighten a piece of pipe, repair leaky cooler pipe, unclog plugged pipe, repair pump.</li> </ol>	

## Farm Pipework (continued)

## References:

1. Cook, G. C., Scranton, L. L., and McColly, H. F., Farm Mechanics Text and Handbook.
2. Jones, Mack M., Shopwork on the Farm.
3. U.S.D.A., Farmer's Bul. No. 1426, Farm Plumbing.
4. U.S.D.A., Farmer's Bul. No. 1460, Simple Plumbing Repairs in the Home.

Teaching Unit: Glazing

Hours: 4

Ability to:	Suggested Teaching-Learning Activities
<b>A. Select materials and equipment.</b>	
1. Glass: kinds, thicknesses, characteristics	Show tools and different kinds of glass.
2. Glass cutters	
3. Putty: for wood sash, for steel sash	
4. Putty knives	
<b>B. Measure and cut glass.</b>	
1. Measuring and marking methods	Demonstrate cutting and breaking glass.
2. Cutting: holding glass, starting cut	Have students practice cutting glass.
3. Breaking glass	
<b>C. Putty a pane of glass.</b>	
1. Preparing sash for putty	Show tricks in securing a smooth putty job. Use 6"x8" frames (made in shop) for student practice in glazing a window.
2. Mixing putty to proper consistency: adding liquid, kneading	
3. Back puttying	
4. Installing glazier points: distance apart, driving points	
5. Puttying pane: methods, holding knife, finishing corners	
<b>D. Replace a broken pane in a wood or steel sash.</b>	
1. Cleaning groove of sash	Each student replace a pane of glass.
2. Measuring and cutting glass	Replace all broken panes in the shop and classroom.
3. Installing glass	

## Glazing (continued)

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Ability to:	Suggested Teaching-Learning Activities
E. Repair a wooden sash	
1. Removing sash	
2. Reinforcing corners	
3. Refinishing sash	
4. Replacing glass	

## References:

1. Cook, G. C., Scranton, L. L., and McColly, H. F., Farm Mechanics Text and Handbook.
2. Jones, Mack M., Shopwork on the Farm.

Teaching Unit: Hot Metal Work

Hours: 8

Ability to:	Suggested Teaching-Learning Activities
A. Know the importance of hot metal work on the farm.	
1. Common forging jobs that may be done by farmers	
B. Know the characteristics of and be able to identify the metals commonly forged.	Demonstrate how to identify these metals by spark test, fracture, hardness, color, sound.
1. Mild steel and wrought iron	
2. Tool steels: carbon steel, high-speed steel, others.	
C. Know the common forging tools and their uses.	Show how these different forge tools are used.
1. Forge and its parts	Show how to select tongs for different sizes and shapes of metal.
2. Anvil and its parts	
3. Tongs: pickup, bolt, etc.	
4. Hammers, kinds and sizes: ball pein, cross pein, straight pein, etc.	
5. Anvil tools: hardy, hot cutter, cold cutter, swages, fullers, flatters, etc.	
D. Build and maintain a forge fire.	Demonstrate approved forging practices in accordance with items under D through I in this unit.
1. Characteristics of a good fire.	
2. Starting a fire: fuel to use, method of starting	
3. Holding a fire: banking, wetting, replacing fuel, making coke	
4. Cleaning a fire	
E. Heat irons in a forge.	

## Hot Metal Work (continued)

Ability to:	Suggested Teaching-Learning Activities
1. Condition of fire	
2. Position of irons while heating	
3. Use of blower	
4. Preventing scaling	
5. Color to heat: low carbon steel, high carbon steel	
F. Shape hot metal.	
1. Selecting proper tongs, and when necessary, shaping jaws to fit metal.	Make an eyebolt from 3/8" rod, 10" long, with a 2" eye. Show how to determine length of rod necessary and how to shape the eye. In cold metal work, show how to thread the bolt.
2. Straightening	
3. Bending	
4. Drawing	
5. Upsetting	
6. Twisting	
G. Cutting hot metal.	
1. Using hardy	
2. Using a hot cutter	
H. Punch holes in hot metal.	
1. Upsetting	
2. Punching the eye	
I. Shape and temper tool steel.	
1. Colors to observe in heating	Forge a cold chisel or punch, or recondition an old tool to demonstrate these practices.
2. Heating and shaping	

## Hot Metal Work (continued)

Ability to:	Suggested Teaching-Learning Activities
3. Annealing	Using good lighting, demonstrate tempering a cold chisel. Show the flow of colors.
4. Hardening before tempering	
5. Tempering: methods, colors to observe	
J. Construct and repair hot metal projects in school and home shop	
1. Make: Cold chisels, center punches, eye bolts, hay hooks, clevis and pin, tire tools, wrecking bars, gate hooks, harrow teeth, iron braces, chain links, chain rings, foot scraper, meat hooks, gate hinges, staple puller	After practicing the basic forging skills, each student make and recondition one or more projects.
2. Recondition or temper: Chisels, punches, picks, harrow teeth, screw drivers, forge tongs, sharpen and retemper pick axes.	

## References:

1. Agricultural Engineering Department, University of Idaho, Forge Work.
2. Cook, G. C., Scranton, L. L., and McColly, H. F., Farm Mechanics Text and Handbook.
3. Jones, Mack M., Shop Work on the Farm.
4. Smith, Robert E., Units in Forging and Welding.

Teaching Unit: Making and Using Drawings and Plans

Hours: 10

Ability to:	Suggested Teaching-Learning Activities
A. Appreciate the value of making and using drawings and plans.	
1. Interpreting ideas to others	
2. Gaining structural ideas from others	
3. Saving material when building projects	
4. Basis for making a bill of materials for a project	
B. Know the common types of projections.	Illustrate with a folding box or a box and glass the relationship of orthographic views to each other.
1. Orthographic: views, relationship of views to each other	
2. Pictorial: isometric and oblique	
3. Value and uses of each	
C. Read and interpret simple drawings.	Hand out duplicate copies of simple drawings or views and have students interpret shape and dimensions.
1. Shape of object	
2. Dimensions	
3. Minor details	
D. Know and be able to use conventional lines and symbols.	
1. Hidden edges	Show how these conventions are used in drawings.
2. Broken lines	
3. Center lines	
4. Dimension lines	
5. Others	
E. Dimension drawings properly.	Illustrate on board and with

## Making and Using Drawings and Plans (continued)

Ability to:	Suggested Teaching-Learning Activities
<ol style="list-style-type: none"> <li>1. Correct method of making dimension and extension lines</li> <li>2. Proper location of dimensions on drawing</li> </ol>	<p>drawings the correct and incorrect methods of dimensioning drawings.</p>
<p>F. Make freehand sketches.</p>	<p>Students draw irregular blocks of wood and other simple objects, making both pictorial and orthographic projections.</p>
<ol style="list-style-type: none"> <li>1. Choosing views</li> <li>2. Using different projections: orthographic, pictorial</li> <li>3. Projecting the views</li> </ol>	
<p>G. Letter neatly and correctly.</p>	<p>Students make a page each of upper and lower case letters and numerals.</p>
<ol style="list-style-type: none"> <li>1. Upper case</li> <li>2. Lower case</li> <li>3. Numerals</li> </ol>	
<p>H. Make working drawings to scale.</p>	<p>Draw a nail box, bench hook or other simple object, then make a more complex drawing, such as a work bench or a plan for a farm workshop.</p>
<ol style="list-style-type: none"> <li>1. Selecting equipment: scale, T square, triangles, drawing board</li> <li>2. Choosing views and projections</li> <li>3. Fastening paper: methods of</li> <li>4. Choosing scale</li> <li>5. Making drawing</li> </ol>	
<p>I. Read and interpret more complex drawing and blueprints.</p>	<p>Interpret and criticize floor plans of houses and barns. Use large drawings or duplicate copies of smaller drawings.</p>
<ol style="list-style-type: none"> <li>1. Buildings: floor plans and elevations</li> <li>2. Sectional views and details</li> </ol>	

## Making and Using Drawings and Plans (continued)

Ability to:	Suggested Teaching-Learning Activities
J. Select and make drawings and plans for school and home projects.	Students make a drawing of at least two projects to be built in shop.
1. Plans for: Work bench, hog feeder, hog trough, milk stool, welding table, welding stool, nail and screw box, farm shop, poultry house, hay feeders, stanchions.	

## References:

1. Cook, G. C., Scranton, L. L., and McColly, H. F., Farm Mechanics Text and Handbook.
2. Jones, Mack M., Shop Work on the Farm.
3. Duplicate copies of correct and incorrect drawings and prints.

## Teacher references:

1. Berg, Edward, Mechanical Drawing.
2. Mattingly, E. H., and Scrogin, Everett, Applied Drawing and Design.

Teaching Unit: Oxy-Acetylene Welding

Hours: 18

Ability to:	Suggested Teaching-Learning Activities
<p>A. Recognize the advantages and disadvantages of oxy-acetylene welding.</p> <ol style="list-style-type: none"> <li>1. Jobs that can be done with equipment</li> <li>2. Saving in time and cost of doing jobs</li> <li>3. Cost of welding equipment and usable materials</li> </ol>	
<p>B. Recognize dangers and use precautions in welding.</p> <ol style="list-style-type: none"> <li>1. Handling oxygen and acetylene tanks</li> <li>2. Sparks and splattering metal</li> <li>3. Spontaneous combustion: oil, oily rags</li> <li>4. Handling hot metal</li> <li>5. Protecting the eyes</li> <li>6. Using proper clothing</li> </ol>	
<p>C. Select equipment and materials.</p> <ol style="list-style-type: none"> <li>1. Manufacturers, quality and size of torches and regulators</li> <li>2. Tanks: sizes, pressures, whether to own or rent</li> <li>3. Generators: kinds, sizes, whether to purchase</li> <li>4. Rods and fluxes: kinds, sizes, uses, cost</li> <li>5. Other equipment: goggles, lighters, tip cleaners, gloves, etc.</li> </ol>	<p>Place all equipment and materials where students can see and handle during discussion.</p> <p>Demonstrate how to replace lens in goggles and flints in friction lighters.</p>

## Oxy-Acetylene Welding (continued)

Ability to:	Suggested Teaching-Learning Activities
D. Properly hook up equipment, dismantle equipment, and light and adjust welding and cutting torches.	Teacher demonstrate these practices and try out at least one student. When lighting and adjusting cutting torch, try out three or four students after demonstration. Use students to check other students.
1. Distinguishing between oxygen and acetylene equipment	
2. Procedures in fastening tanks, blowing out valves, putting on regulators, hooking up hoses and torches, etc.	
3. Proper steps in opening tank, hose and torch valves, and securing working pressures	
4. Proper steps in closing valves and regulators and draining hoses	
5. Lighting and adjusting blowpipe to carborizing, neutral and oxidizing flames	
6. Lighting and adjusting cutting torch	
7. Dismantling and storing equipment	
E. Control backfires and flashbacks.	
1. Backfires: causes and controls	
2. Flashbacks: causes and controls	
F. Cut metal with cutting torch	
1. Adjusting working pressure to particular torch and to thickness of metal	(Do not allow a student to weld until he has been checked off for properly hooking up equipment, lighting and adjusting torches, cutting metal, making melt strips and running beads. An advanced student may help check students on these skills.)
2. Starting cut, angle of torch, distance from metal, speed of travel, keeping cut free from slag	

## Oxy-acetylene Welding (continued)

Ability to:	Suggested Teaching-Learning Activities
3. Cutting thin metal, heavy plate, rivet heads, holes	
4. Cutting angle iron, pipe, cast iron and other miscellaneous materials	
G. Manipulate torch and rod.	Demonstrate each skill under G through L in this unit.
1. Making melt strips or puddles	
2. Running beads	
H. Weld wrought iron and mild steel	Grade each weld after inspecting and testing. (A weld should not break when bent at a 90° angle.) For uniformity, use 2" x 5" pieces for butt welds, Tee joints and lap welds.
1. Proper beveling and spacing of joints	
2. Tacking joints	
3. Making thin butt welds	
4. Making thick butt welds	
5. Building up or padding metal	
6. Making lap joints	
7. Making Tee joints	
8. Welding pipe	
9. Other types of joints	
I. Bronze or braze metal	
1. Tinning the joint	
2. Bronzing mild steel	
3. Bronzing cast iron	
J. Weld cast iron	Test cast iron welds by striking with a hammer. The piece should break at the side of the weld, not in the weld.
1. Preparing metal: grooving, pre-heating	

## Oxy-Acetylene Welding (continued)

Ability to:	Suggested Teaching-Learning Activities
2. Welding	(Some of the more difficult welds may be postponed until the following year, at which time the simpler welds should be repeated, then advance to more difficult welds.)
3. Cooling metal	
K. Hard surface metal: plow points, cultivator points.	
L. Weld in different positions	
1. Horizontal weld	
2. Vertical weld	
3. Overhead weld	
M. Construct and repair welding projects in the school shop and on the farm.	After learning the basic skills, each student should do one or more welding projects.
1. Make: Welding table, chipping hammer, saw horse, trailer hitch, clothes line posts, iron rack, milk stool, soil moisture probe	
2. Repair: Broken chain, broken casting, pieces of farm machinery, bumper, hoes, shovels, holes in tanks and barrels, cylinder heads, gear teeth, plow discs, pipes.	

## References:

1. Cook, G. C., Scranton, L. L., and McColly, H. F., Farm Mechanics Text and Handbook (1946).
2. Jones, Mack M., Farm Shopwork.
3. Smith, Robert E., Units in Forging and Welding.

## Teacher References:

1. How to Bronze Weld, The Linde Air Products Company.
2. The Oxy-Acetylene Handbook, The Linde Air Products Company.

Teaching Unit: Painting

Hours: 11

Ability to:	Suggested Teaching-Learning Activities
A. Know the principles of painting.	
1. Value of painting: appearance, wear, increased real estate value	
2. Number of coats or thickness of a good paint film	
3. Characteristics of a good paint: durable, self cleaning (outside paint), good hiding value, fast color, washable - for most uses, easy to apply, etc.	
4. Weather for painting: temperature, moisture	
B. Know the characteristics of paint ingredients.	Show different ingredients of paints and demonstrate their characteristics in oil.
1. Vehicles: linseed oil (boiled and raw), soy bean oil, tung oil, others	
2. Thinners: turpentine, mineral spirits	Show samples of various types of paints such as white lead - linseed oil base, resin base, cement base, varnish, enamel, synthetic base, etc.
3. Pigments: white lead, red lead, zinc oxide, titanium dioxide, silicon dioxide, calcium carbonate, others.	
4. Driers	
C. Prepare surfaces for painting	
1. Tools to use	
2. New wood surface	Show paint failures where the surface was not properly prepared.
3. Wood surface with old paint job	
4. Masonry surface	
5. Metal surface	

## Painting (continued)

Ability to:	Suggested Teaching-Learning Activities
6. Removing old paint and varnish	
7. Filling cracks and holes	
8. Removing dirt, grease, etc.	
D. Select and care for painting equipment.	Drill holes in brush handles for temporarily storing in buckets.
1. Selecting brushes for: large surfaces, trimming, varnishing	
2. Breaking in new brushes	
3. Cleaning brushes and restoring old brushes	Have students bring old brushes to school and reclaim them.
4. Storing brushes	
5. Cleaning buckets and other equipment	
E. Prepare factory made paint for painting	
1. Mixing: pouring off liquid, stirring paste, boxing and mixing	Paint a building or large project. Have each student apply paint with brush and spray gun. Show how to use brush to paint edges of boards and windows.
2. Tinting: selecting colors, preparing colors, adding colors to paint, matching old paint, saving sample of tinted paint	
3. Thinning paint	
F. Apply paint with a brush	
1. Selecting size and type of brush for purpose	
2. Dipping brush	
3. Removing excess paint	
4. Holding brush	

## Painting (continued)

Ability to:	Suggested Teaching-Learning Activities
5. Applying paint: starting to paint, brushing out laps, painting difficult places, etc.	
G. Apply paint with a paint sprayer.	
1. Selecting appropriate sprayer for rent or purchase	
2. Filling and adjusting: thinning paint, adjusting pressure, adjusting nozzle	
3. Applying paint: amount, feathering out, starting and stopping	
4. Cleaning paint spray equipment: method, materials to use	
H. Purchase and use paint for specific purposes.	Show samples of paints with good and poor formulas.
1. Knowledge of conditions to which paint will be submitted: weather, wear, dirt, moisture, etc.	
2. Buying from reliable dealers - guarantees	
3. Reading and interpreting paint formulas on the can	
4. Ingredients that are harmful to some paints: water and considerable inert pigments in white lead-linseed oil paints, etc.	
5. Following exact directions on can for mixing and using new type paints	
I. Paint outside wood surfaces	
1. Selecting paint: linseed oil, white lead base	

## Painting (continued)

Ability to:	Suggested Teaching-Learning Activities
2. Preparing surface: sealing knots, cleaning, etc.	
3. Preparing paint for different coats: adding thinners, driers	
4. Painting a new wood surface: primer, second coat, finish coat	
5. Repainting a wood surface: first coat, finish coat	
J. Paint metal surfaces.	Paint farm machinery brought in for repair.
1. Cleaning surface	
2. Priming coat: purpose, materials	
3. Finish coat: hard wearing paint or enamel	
K. Use stains, varnishes, enamels and lacquers	
1. Stains: types, colors, methods of applying	
2. Varnishes: constituents of varnish, types (spar, flat, varnish stain), uses, methods of applying	
3. Enamels and lacquers: constituents, uses, applying under coat of paint, applying finish coat	
4. Applying a natural wood finish on a project	
a. Preparing wood: cleaning, sanding	
b. Applying filler (if open grained)	
c. Applying stain (optional)	
d. Applying boiled linseed oil	

## Painting (continued)

Ability to:	Suggested Teaching-Learning Activities
e. Applying coats of varnish	
L. Paint outside masonry surfaces	
1. Selecting paint	
a. Cement base paint: cheap, easy to apply, resistant to inside moisture, flat, semitransparent when wet	
b. Linseed oil, white lead paint: durable, glossy, self cleaning, opaque when wet	
2. Cleaning surface	
3. Mixing: adding water to cement base paint	
4. Applying sealer to prevent suction and alkali spots (for oil paints only)	
5. Applying paint	
a. Cement base paint: spreading quickly with wide brush	
b. White lead paint: brushing in well	
6. Curing with water: (cement base paints only)	
7. Select and apply resin-emulsion paints	
M. Select paint and paint the interior of a house.	
1. Paints for bedrooms, living room	
a. Flat finish oil paint	Demonstrate the appearance and gloss of several of these paints.

## Painting (continued)

Ability to:	Suggested Teaching-Learning Activities
<ul style="list-style-type: none"> <li>b. Flat finish water paints: resin-oil emulsion, casein</li> <li>c. Gloss paints: washable, for trim</li> </ul>	
2. Paints for kitchen, bathroom	
<ul style="list-style-type: none"> <li>a. Semigloss finish oil paints</li> <li>b. Full-gloss finish enamels</li> </ul>	
3. Preparing surfaces for different paints	
4. Applying different kinds of paints	
<ul style="list-style-type: none"> <li>a. Brush or roller for water paint</li> </ul>	
N. Paint floors and porches	
<ul style="list-style-type: none"> <li>1. Selecting paint</li> <li>2. Applying</li> </ul>	
O. Choose appropriate colors for buildings	
<ul style="list-style-type: none"> <li>1. Outside paint: light tints</li> <li>2. Trim: bright colors</li> <li>3. Inside paint</li> </ul>	<p>Show how light paints lighten the interior of a room, how light colors bring out the colors or flowers, and how bright trim colors make buildings stand out. List the cool colors and warm colors.</p>
P. Recognize and control different paint failures	
<ul style="list-style-type: none"> <li>1. Alligatoring</li> <li>2. Bleeding</li> <li>3. Blistering and peeling</li> <li>4. Cracking and scaling</li> <li>5. Running and sagging</li> </ul>	<p>Show samples of wood with different paint failures or take field trip to see paint failures (army barracks usually show paint failures).</p>

## Painting (continued)

Ability to:	Suggested Teaching-Learning Activities
6. Wrinkling	
7. Tackiness and slow drying	
8. Failures due to certain kinds of woods	
Q. Determine the amount of paint and cost of painting a building.	Have students figure the amount of paint and cost of paint for different buildings.
1. Surface area covered by a particular paint on a particular surface	
a. Wood, masonry, metal, etc.	
b. Number of coats to apply	
c. Coverage for each coat	
2. Surface area in building	
a. Walls	
b. Eaves	
c. Roof or ceiling	
d. Total area to be painted	
3. Gallons of paint necessary	
4. Cost of the paint	
R. Paint projects in school shop and on the farm	After learning the basic painting skills, each student paint one or more projects. Every wood or wood-metal project should be painted or treated before it is taken from the shop.
1. Paint: Trailer, chicken coop, dairy barn, outside of house, small shop projects, pieces of farm machinery, tractor, picket fence.	

## Painting (continued)

## References:

1. Cook, G. C., Scranton, L. L., and McColly, H. F., Farm Mechanics Text and Handbook.
2. Jones, Mack M., Shopwork on the Farm.
3. N. Dakota State Laboratories Department Bul. No. 62, Farmer's Paint Bulletin.
4. University of Nebraska Agr. Ext. Ser. Cir. No. 732, Selecting and Applying Paints.

## Teacher references:

1. Schmidt, G. A., Instructor's Manual for Teaching Exterior Painting of Farm Buildings and Equipment.
2. Walker, Percy H., and Hickson, Eugene F., Paint Manual With Particular Reference to Federal Specifications.

Teaching Unit: Rope Work

Hours: 6

Ability to:	Suggested Teaching-Learning Activities
<p>A. Select and care for rope.</p> <ol style="list-style-type: none"> <li>1. Types and characteristics of rope materials: hemp, jute, cotton, sisal, nylon, etc.</li> <li>2. Rope preservatives and lubricants</li> <li>3. Forming rope: fibers, yarns, strands</li> <li>4. Care of rope: coiling, relieving kinks</li> <li>5. Breaking strength, safe load, and weight formulas</li> </ol>	<p>Identify various kinds of rope and give their characteristics. Present different rope materials and show on a map where they were produced.</p> <p>Practice coiling, unlaying and laying a rope.</p>
<p>B. Finish ends of rope</p> <ol style="list-style-type: none"> <li>1. Whipping</li> <li>2. Crown splice</li> <li>3. Matthew Walker knot</li> </ol>	<p>Soak rope in water to determine the effect of moisture on various materials.</p>
<p>C. Select and tie common knots and hitches and know the uses and advantages of each.</p> <ol style="list-style-type: none"> <li>1. Ways in which rope can be used on the farm</li> <li>2. Essentials of a good knot or hitch</li> </ol>	<p>Demonstrate whipping, crown splice and common knots and splices.</p> <p>Secure ends of a rope by whipping a crown knot; then cut into and make a short splice.</p>
<p>D. Make simple splices: short, long, eye, loop</p> <ol style="list-style-type: none"> <li>1. Essentials and characteristics of a splice</li> <li>2. Making each splice</li> </ol>	<p>Use a rope board to show appearance of common knots and splices.</p>
<p>E. Make a rope halter</p>	

## Rope Work (continued)

Ability to:	Suggested Teaching-Learning Activities
1. Selecting the rope: length, diameter, kind.	Students bring a 1/2" or 3/8" rope, 10' long to make halter. Jute rope is the cheapest, softest, and easiest to work.
2. Making the knots and splices	
F. Understand and use pulleys, and blocks and tackle	
1. Reeving a set of blocks	Demonstrate how to reef a block.
2. Resistance and force of pulleys	
G. Use rope in handling livestock	Have a cowboy or rancher demonstrate how a rope should be used with livestock.
1. Cows: casting, leading	
2. Horses: casting, forcing to lead, forcing in trailer	
3. Using a lariat rope	
a. Characteristics of a good lariat - kind of materials, length, weight of rope, making the eye or hondo	
b. Throwing the lariat: size of loop, keeping loop open, swinging loop, throwing loop, closing loop	

## References:

1. Cook, G. C., Scranton, L. L., and McColly, H. F., Farm Mechanics Text and Handbook.
2. Jones, Mack M., Shopwork on the Farm.
3. Manual of Rope Usage, Plymouth Cordage Company, Plymouth, Mass.
4. Ohio State University Agr. Ext. Ser. Bul. No. 82, The Use of Rope on the Farm.
5. U.S.D.A., Farmer's Bul. No. 1931, Care and Use of Rope on the Farm.

Teaching Unit: Selecting Lumber and Hardware and Figuring Bills of Materials Hours: 5

Ability to:	Suggested Teaching-Learning Activities
A. Know the different characteristics of lumber and how to buy it.	Study samples of wood and identify. Classify these woods as to strength, hardness, wear resistance, etc.
1. Kinds of wood and their characteristics	
a. Soft woods: pine, spruce, fir, redwood, cedar, cypress, hemlock	Demonstrate the variation in hardness of some woods.
b. Hard woods: oak, maple, hickory, walnut, ash, birch	
2. Kind of wood to use for different farm purposes	Identify the woods in projects and tools in the school shop.
a. Rough dimension lumber	
b. Cabinets, trim and siding	
c. Wood to resist rotting	
d. Handles, tongues, machinery, hardwood floors	
e. Benches, trailer beds, etc.	
3. Common grades of lumber	
a. Select grades	
b. Common grades	
c. Grades of hard wood	
d. Defects of lumber and how they affect it.	
4. Stock sizes of lumber	On a field trip to a lumber yard, have lumberman grade lumber and show lumber defects. Show different kinds of lumber and purposes for which each is sold.
a. Lengths commonly carried by lumber yards	
b. Actual width and thickness	

Selecting Lumber and Hardware and Figuring Bills of Materials (continued)

Ability to:	Suggested Teaching-Learning Activities
<p>of stock lumber such as 2" x 4"s and 1" x 6"s</p> <p>c. Size of planks; timbers</p>	
<p>5. Figuring board feet in a piece of lumber</p> <p>a. Scaling</p> <p>b. Using the lumber formula</p>	<p>Give students lumber problems for practice.</p> <p>Students help make a lumber bill for the school shop, and when the lumber arrives, check it against the bill as to the grade and board feet.</p>
<p>6. Figuring a lumber bill</p> <p>a. Amount of lumber</p> <p>b. Cost</p>	
<p>7. Lumbering methods that affect lumber</p> <p>a. Methods of sawing</p> <p>b. Methods of curing and drying</p> <p>c. Amount of lumber procured from a log</p> <p>d. Care in grading lumber</p> <p>e. Caring for lumber: handling, storing</p>	
<p>B. Select nails for specific uses</p> <p>1. Kinds of nails: common, box, finishing, etc.</p> <p>2. Uses and characteristics of the different kinds</p> <p>3. Sizes of nails: 2D to 60D</p>	<p>Show samples of different kinds of nails and get students familiar with sizes of nails.</p>

## Selecting Lumber and Hardware and Figuring Bills of Materials (continued)

Ability to:	Suggested Teaching-Learning Activities
C. Select screws for specific purposes	Lay 30 or more samples of nails, screws and other hardware in numbered squares for students to identify and determine size.
1. Kinds of screws: flat head, round head, lag, etc.	
2. Uses and characteristics of the different kinds	
3. Finish of screws: blued, brass, nickel, etc.	
4. Sizes of screws: length, gauge or diameter	
D. Select and use bolts.	Illustrate how different kinds of bolts are being used in machinery and projects in the school shop.
1. Machine: uses and characteristics	
2. Carriage: uses and characteristics	
3. Stove bolts and machine screws: uses and characteristics	
E. Select and use hinges	
1. Kinds of hinges: strap, butt, T, cabinet, etc.	
2. Uses and characteristics of the different kinds	
3. Finish of hinges: steel, brass, nickel, etc.	
F. Select and use locks.	
1. House door locks: kinds and characteristics	
2. Padlocks: kinds and characteristics	
3. Locks for garden and corral gates	

Selecting Lumber and Hardware and Figuring Bills of Materials (continued)

Ability to:	Suggested Teaching-Learning Activities
<p>G. Select and use other miscellaneous hardware.</p> <ol style="list-style-type: none"> <li>1. Washers: kinds and uses of each</li> <li>2. Nuts: kinds and uses of each</li> <li>3. Expansion shields: types and uses</li> <li>4. Toggle bolts: types and uses</li> <li>5. Door pulls</li> <li>6. Hasps</li> <li>7. Corner braces</li> <li>8. Elbow catches and door buttons</li> <li>9. Others</li> </ol>	<p>Visit hardware store to get students acquainted with how to buy different kinds of hardware.</p>
<p>H. Make a bill of materials for a project.</p> <ol style="list-style-type: none"> <li>1. Interpreting plans or measuring projects to:           <ol style="list-style-type: none"> <li>a. Determine exact size and kind of each piece of wood</li> <li>b. Determine size, kind, and number of screws, nails, bolts and other hardware</li> <li>c. Determine kind, size and shape of metal used</li> </ol> </li> <li>2. Determining stock bill as it would have to be purchased           <ol style="list-style-type: none"> <li>a. Lumber: nominal width and thickness, length, grade, etc.</li> <li>b. Metal: size and type</li> </ol> </li> </ol>	<p>Hand out multiple copies of a plan for a wood-metal project. Have each student make a bill of materials for the project and determine the cost</p> <p>Students make bill of materials for each major project built.</p>

## Selecting Lumber and Hardware and Figuring Bills of Materials (continued)

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Ability to:	Suggested Teaching-Learning Activities
3. Determining costs	
a. Lumber	
b. Metal	
c. Nails, screws, bolts, and other hardware	
d. Total cost	

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1. Cook, G. C., Scranton, L. L., and McColly, H. F., Farm Mechanics Text and Handbook.
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4. U.S.D.A., Farmers Bul. No. 1756, Selection of Lumber for Farm and Home Building.

Teaching Unit: Soldering and Sheet Metal Work

Hours: 9

Ability to:	Suggested Teaching-Learning Activities
A. Appreciate the importance and value of sheet metal work on the farm.	
1. What soldering is and how it is done	
2. Repair jobs that may be done	
3. Constructing special sheet metal projects	
4. Time and money saved	
B. Select materials and equipment for soldering.	Have tools and equipment where students can see and handle during discussion.
1. Soldering irons or coppers	
a. Kinds, sizes and uses of common irons	
b. Electric soldering irons: type and sizes	
2. Heating equipment	Cut a hole in the side of a twelve-inch length of a three or four inch pipe and mount it on a pedestal. Use this as a device for heating several soldering irons at one time with one blow torch.
a. Blow torch and gasoline fire-pot: sizes and types	
b. Acetylene torch, alcohol torch, furnace, gas burner, and others	
3. Solder	
a. Forms of solder: bar, wire, acid, and rosin core	
b. Kinds of solder: 50-50, 40-60, 30-70, etc.	
4. Fluxes	
a. Kinds of fluxes, their uses	

## Soldering and Sheet Metal Work (continued)

Ability to:	Suggested Teaching-Learning Activities
and characteristics: corrosive fluxes, non-corrosive, acids, salts, pastes	
5. Other equipment: rivet sets, tin snips, sheet metal screws	
C. Know metals that can be soldered	Show soldered projects of different kinds of metal.
1. Ease of soldering sheet iron, galvanized sheet iron, tin, lead, aluminum, copper, brass, others	
D. Operate blow torches	
1. Filling the blow torch: two-thirds full, wiping dry	
2. Starting the blow torch: pumping up, priming, lighting, generating	
3. Identifying troubles and repairing blow torch: insufficient generation, clogged tip, dirty fuel, leaky fittings, carbon deposits, leaky or worn pump, sticky check valve, worn out wick, etc.	Make chart with possible troubles and remedies.
4. Observing safety rules in operating blow torches	Emphasize fire dangers.
E. Tin as a soldering copper.	After demonstration and try-out of student, have student check off other students.
1. Purpose: removing oxide, making heat flow readily	
2. Cleaning and shaping	
3. Applying coat of solder	
F. Solder holes in sheet metal objects	Display projects with different types of repairs.
1. Heating the iron: method, temperature	

## Soldering and Sheet Metal Work (continued)

Ability to:	Suggested Teaching-Learning Activities
2. Selecting solder and flux for the particular metal	
3. Soldering small holes and cracks, using solder only	
4. Repairing hole with rivet and solder	
5. Repairing hole with patch and solder	Demonstrate acceptable practices in doing the skills from D to M of this unit.
a. Sweating on patch	
b. Soldering edges	
G. Soldering seams.	
1. Cleaning and fluxing	
2. Running solder	
H. Rivet sheet metal objects	
1. Selecting rivets: length, diameter	
2. Punching or drilling hole	
3. Heading the rivet	
I. Use sheet metal screws	
1. Drilling holes	
2. Selecting screws	
J. Cut sheet metal.	
1. Cold chisel	
2. Hack saw	
3. Straight shears	
4. Circle cutting shears	

## Soldering and Sheet Metal Work (continued)

Ability to:	Suggested Teaching-Learning Activities
K. Solder aluminum objects.	
1. Selecting solder and flux	
2. Method of soldering	
L. Repair pipe	
1. Materials	
2. Methods	
M. Lay out sheet metal work	
1. Measuring and marking	
2. Cutting	
3. Forming	
N. Construct sheet metal projects in the school shop and on the farm.	After acquiring the basic skills, each student make and/or repair one or more sheet metal projects. Encourage students to bring in all damaged sheet metal objects and repair them.
1. Make: feed scoop, tractor funnel, soldering electric wire connections, dust pan, salt box, tractor power-takeoff guard, light reflector, tool grinding angle gage.	
2. Repair: Chicken feeders, tubs, pails, kettles, metal roof, poultry drinking containers, cracked tubing, cracked pipe, radiator, cracked faucet, sheet metal nests, brooders, gas tanks, coolers.	

## Soldering and Sheet Metal Work (continued)

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5. Smith, Robert E., Units in Sheet Metal Work.

Teaching Unit: Tool Conditioning and Handle Fitting

Hours: 9

Ability to:	Suggested Teaching-Learning Activities
A. Select, service and use grinders	
1. Sizes and types of grinders	
2. Stones: width, grain, grade	
3. Testing and mounting a wheel	
4. Dressing a grinding wheel	
5. Observing safety precautions in using	Make students safety conscious when using grinder. Keep goggles or face shields above grinding wheel where they cannot be overlooked.
B. Select and use oil stones.	
1. Types and combinations of stones	
2. Cleaning and oiling the stone	
C. Sharpen knives	Emphasize caution against over heating when grinding thin edge tools.
1. Grinding: when to grind, method	
2. Whetting method	
3. Testing for sharpness	Show several methods of checking edge tools for sharpness - shaving hairs, feel, light reflection, etc.
4. Sharpening butcher knives	
a. Grinding: when to grind, method	
b. Whetting method	
D. Sharpen axes and hatchets	
1. Grinding: when to grind, method	
2. Whetting method	
E. Sharpen plane bits and wood chisels	Demonstrate the difference between sharp tools and dull tools in ease of using and quality of workmanship.
1. Type of file to use	
2. Filing scoring nibs	

## Tool Conditioning and Handle Fitting (continued)

Ability to:	Suggested Teaching-Learning Activities
3. Filing cutting lips	
G. Sharpen twist drills	Drill holes with a sharp bit and an improperly sharpened bit. Show how the shavings curl when a bit is sharp and the proper pressure is used.
1. Proper shape of drill point	
2. Lip clearance	
3. Length and angle of cutting edges	Keep a tool grinding gage at the grinder and use gage to check angles of different tools while sharpening.
4. Placing drill in position	
5. Grinding the drill	
6. Grinding a drill for special materials	
H. Sharpen cold chisels and punches	
1. Cutting angle of cold chisel	Show how a chisel with too sharp an angle will not stand up under heavy chiseling.
2. Method of grinding chisel	
3. Grinding center punches	
4. Grinding prick and pin punches	
I. Fit screw drivers	
1. Angle, shape and thickness of blade	
2. Re-shaping and re-tempering	
J. Sharpen scissors and snips	
1. Angle to grind	
2. Grinding and whetting	
K. Sharpen hoes, mattock, spades and shovels	
1. Straightening nicks and dents on edge	

Tool Conditioning and Handle Fitting (continued)

Ability to:	Suggested Teaching-Learning Activities
2. Holding the tool	
3. Grinding or filing	
L. Sharpen scythes, grass sickles and draw knives	
1. Tools to use	
2. Method of sharpening	
M. Sharpen mower sickles	
1. Type of equipment	
2. Method of sharpening	
N. Sharpen cross cut and rip hand saws	
1. Shape of teeth and how each saw cuts	From a piece of 1" x 10" board, cut an enlarged section of rip and cross cut saw teeth to use for illustrating differences in teeth of each saw.
2. Jointing	
3. Setting	
4. Filing a cross cut saw	
5. Filing a rip saw	
O. Replace handles in tools	
1. Axe and hatchet handles: removing old handle, fitting new handle, wedging.	Emphasize that burning out handles will draw the temper out of tools.
2. Hammer handles: removing old handle, fitting new handle, wedging.	
3. Shovel, hoe and rake handles: removing old handle, shaping new handle, riveting.	

## Tool Conditioning and Handle Fitting

Ability to:	Suggested Teaching-Learning Activities
4. Fork handles	
5. Saw handles	
<b>P. Clean Tools.</b>	
1. Removing rust	
2. Oiling	
<b>Q. Condition and fit tools in school and farm shops</b>	Encourage students to gather together all the tools in the house and in the farm shop and recondition them. Each student sharpen six or more different kinds of tools, replace handles in one or more tools and clean and oil one or more tools.
1. Sharpen: Pocket knives, butcher knives, hoes, shovels, twist bits, cold chisels, wood chisels, plane bits, scissors, screw drivers, punches.	
2. Replace handles in: Axes, hatchets, hammers, sledges, hoes, shovels, saws.	
3. Clean and oil: Saws, bit braces, auger bits, axes.	

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The Linde Air Products Company, New York, 1945. 587 pp.

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U. S. Department of Agriculture, Washington, D. C., 1943. 17 pp.

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Farmer's Bulletin No. 1832

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## PART V

## SUMMARY AND RECOMMENDATIONS

## Summary

Fourteen teaching units were developed and were so organized as to be of maximum aid to the instructor in planning and teaching the skills, knowledges, understandings and appreciations that may be associated with each area of farm mechanics. Each unit contains the abilities that may be taught in an area of farm mechanics, the content that may be associated with each ability, teaching-learning activities that may be used to teach the abilities, appropriate jobs and projects that may be constructed or repaired by the learner, references that may be used, and the time necessary to teach the unit.

The teaching units treated in this study do not comprise a complete course of study for farm mechanics but they do cover those areas most commonly taught in the farm mechanics courses in Arizona high schools.

Many studies have been made relative to courses of study in farm mechanics, and a large number of courses of study have been prepared for use in different states. In the literature reviewed by the author, there was some agreement on the abilities that should be included in a farm mechanics course of study but a wide variation of opinion existed as to the form to be used for the teaching units, and the content and activities that should be associated with the units.

In developing the farm mechanics teaching units for this study, the units were first analyzed to determine the understandings, skills, knowledges and appreciations that may be gained through the teaching of the unit. These were stated in terms of abilities. Content was then associated with each ability in order to clarify, add meaning or limit the scope of the ability.

Teaching-learning activities were then developed for as many of the abilities as seemed practical. As has been previously stated, teaching-learning activities are activities on the part of the teacher or the pupil (other than reading, class discussion, or note taking) that further the acquisition of the desired abilities by the learner. A list of repair and construction jobs and projects was compiled for each unit. This list was restricted to practical farm jobs and projects which are commonly done on Arizona farms and ranches.

A list of suggested references for the students and teacher was compiled and listed at the end of each teaching unit. These references were selected on the basis of the criteria as stated in the section, Compiling a List of References, Part II of this study.

The units were presented to nine teachers of vocational agriculture in Arizona who served as judges in evaluating the units. These judges were in common agreement on the content of the units but there was a wide variation in opinion as to the time needed for teaching each unit. On the basis of the evaluations offered by the judges, the units were then revised in their present form.

### Recommendations

The following recommendations are made, relative to use at the state level of the teaching units developed in this study:

1. The teaching units should be mimeographed and made available to all teachers of vocational agriculture in Arizona.
2. Special clinics should be held to instruct teachers on the use of the units.
3. After being used for at least one year, the teaching units should be evaluated and revised in accordance with the recommendations of the teachers who have used them.

The following recommendations are made as to the use of the teaching units in departments of vocational agriculture. It is not the thought of the author that every teacher of farm mechanics will teach all of the abilities suggested in the teaching units. Every ability in the list should however be used by some teachers in the state, depending upon local needs. This list of abilities should be used by the instructor as a guide:

1. In selecting the abilities and content to teach in a particular area.
2. For selecting and procuring tools, equipment, and materials for teaching the area.
3. For procuring reference materials and other teaching aids.
4. For making plans and provisions for demonstrations and other teaching procedures appropriate to the teaching content.
5. For planning the instruction of advanced units to young farmer and adult groups.

Since more teaching-learning activities are suggested in each teaching unit than a teacher would have time to use, he must select and use those activities which will most efficiently and economically aid him in teaching the abilities under local conditions.

The suggested teaching-learning activities should be used by the instructor as follows:

1. As a reminder to procure and to use real materials, specimens, charts, films, and other audio-visual materials.
2. To suggest demonstrations, field classes and other teaching methods that will increase the efficiency of the instruction.
3. As a reminder to make preparations in advance for demonstrations and field classes.
4. To suggest participating experiences for the students that will give practice in the skills to be learned.
5. To suggest safety precautions to use while practicing the skills.

Practical farm mechanics jobs provide a means of practicing newly learned skills until they are developed beyond the threshold of learning. Farm mechanics jobs and projects also contribute to the success of farming programs and establishment in farming, which are the major objectives of all instruction in vocational agriculture.

The list of repair and construction jobs and projects should be used to suggest:

1. Jobs and projects that may be constructed or repaired in the school shop to give practice in fundamental skills just learned, and to demonstrate how these skills may be used on a real farm job.

2. Jobs and projects that may be constructed or repaired on the students home farm. These should include improvement projects and supplementary farm jobs performed in the student's farming program.
3. Exhibits that may be made to inform the community on the work and accomplishments of students in the department of vocational agriculture.

The following recommendations are made as to the need for further studies related to courses of study in farm mechanics:

1. Additional studies should be made to determine what skills and knowledges should be taught to high school students in the areas of farm plumbing, farm electricity and wiring, truck and tractor mechanics, construction and repair of farm buildings and other areas that were not treated in this study. It is recommended that farmers be surveyed to determine the jobs they commonly do in these areas and the jobs they would do if they had the required skills.
2. Teaching units with the same organization as used for the units in this study should then be formulated for these areas.
3. Further study and investigation should be made to build up a reservoir of teaching-learning activities and suggested jobs and projects as an addition to the lists developed in this study.
4. A study should be made to provide a list of films, charts, specimens and other audio-visual materials that will be of value in teaching farm mechanics.

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