

THE DEVELOPMENT OF COURSE CONTENT
IN FARM ELECTRIFICATION TO BE USED BY
VOCATIONAL AGRICULTURE TEACHERS OF KANSAS

by

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INTRODUCTION

Electric service has become available to nearly all of the farms in Kansas within the past decade. With this addition, the farm families have been able to enjoy the comforts and conveniences of the urban family. Electricity helps in a thousand daily chores. It assists in lighting homes and farmsteads, operates household appliances, runs motors of every description, makes possible radio and television, operates shop tools, grinds feed, broods pigs and chickens, does the milking, and performs countless other power jobs for the farmer. The use of electricity has removed a great deal of the drudgery and increased the profits of farming. Electricity in the home and on the farm has saved labor and effected economies that were difficult to obtain in any other way. For instance, when electricity was used to operate the water system, more water could be pumped in a short time than a man could pump in a day, and at a fraction of the cost of the man's labor. The employment of electricity for light, heat, and power in a dairy or poultry enterprise has often increased the production and often enabled the farmer to produce a higher quality product at a lower cost, which increased his profits. These benefits to the farmer and his family have caused him to demand more and more electrical service.

The use of electricity on the farm has eased some of the heavy work, but it has also resulted in an increased need of the farmer for new knowledge, new abilities, and new skills. Before the farmer can use electric service to its fullest advantage in

easing his work, lighting dark corners, or increasing his profits, he needs to obtain additional knowledge, abilities, and skills.

After the electrical system was installed, the farmer was confronted with many new problems. The system had to be maintained; equipment had to be purchased and maintained; power consumption had to be kept to a minimum in doing the job it was intended to do; and safety precautions had to be exercised at all times. The present and future farmer needs help with these problems. This help should be provided in such a manner that the adult farmer and future farmer will be able to solve these problems along with other managerial and operative problems that confront them each day.

A complete program of vocational education in agriculture in the high school includes a regularly scheduled and organized farm mechanics program. Farm electrification should form a part of the instruction in the farm mechanics program. The teaching of farm electrification in a community, however, has depended upon the interest, needs, and abilities of the students, facilities available, qualifications of the instructor, and the amount of time available for teaching farm electrification.

To assist the present and future farmers to obtain the additional knowledge necessary, an organized course of instruction in farm electrification appears to be invaluable to the teacher of vocational agriculture. It is anticipated that the results of this study will aid teachers of vocational agriculture in Kansas to organize their farm mechanics programs to provide adequate training in farm electrification for present and

future farmers.

PURPOSE

The purpose of this study was to develop a proposed course of study, and suggested lesson plans and job sheets in farm electrification, to be used as a guide by vocational agriculture teachers in Kansas.

The three objectives of this study were:

1. To determine if there existed a need for instruction in the selection, utilization, maintenance and repair of the farm electrical system and equipment, based upon the reactions of graduates of high school who were farming.

2. To determine, if a need existed, the phases of electricity to be included in the vocational agriculture program from the information received.

3. To develop a proposed course of study and suggested job sheets and lesson plans in farm electrification for use as a guide by vocational agriculture teachers of Kansas, based upon the results of this survey.

SURVEY OF LITERATURE

A Complete Farm Mechanics Program

One of the phases and an integral part of the instruction

in vocational agriculture in high school is farm mechanics instruction. It is just as much a part of the program as is the instruction in farm crops, livestock, or farm management. All of these phases are necessary for a well-rounded program of instruction in vocational agriculture.¹

The present and future farmer should be trained in the knowledge, skills, ideals, and appreciations that he needs to meet the mechanical problems with which he has to deal. There are many jobs on the farm that the farmer should do and that he can do with very little technical training.²

A farm mechanics program includes all the unspecialized mechanical activities that should be done on the farm and in the home with the kind of tools and equipment the farmer has available.³

A complete program of instruction in farm mechanics that will meet the needs of the farmer should contain plans for instruction in the following areas of farm mechanics:

1. Farm shop work
2. Farm power and machinery
3. Farm buildings and conveniences
4. Soil and water management
5. Rural electrification⁴.

¹ Obed L. Snowden, G. C. Cook, and Clyde Walker, Practical Methods in Teaching Farm Mechanics, p. 11.

² Loc. cit.

³ Lloyd J. Phipps and Glen Charles Cook, Handbook on Teaching Vocational Agriculture, p. 689.

⁴ Lloyd J. Phipps, H. F. McColly, L. L. Scranton, and G. C. Cook, Farm Mechanics Text and Handbook, p. 9.

Many departments of vocational agriculture have offered instruction in only several areas of farm mechanics. Inadequate teacher training in the other areas of farm mechanics instruction, tradition, inadequate size of shop, and inadequate equipment, are a few of the reasons for not including all the areas of farm mechanics.¹

More than ever before, people are realizing the need for farm mechanics instruction. The utilization of various forms of mechanical and electrical power on the farm is increasing rapidly. From all indications, the trend toward mechanization will continue.²

The Importance of Electricity on the Farm

The use of electricity on farms has developed rapidly over the United States. However, Kansas has been a little below the national average in progress in extending central-station electric service to farms. Sparse settlements in the western sections, the unfavorable farming conditions in the 1930's, and the shortage of low-cost, dependable power, all contributed to the slow extension of electrical power lines into rural areas. Less than 8 per cent of the farms in Kansas were electrified in 1934, as compared to the national average of 11 per cent. In 1949, 61 per cent of the farms in Kansas had electrical service, while

¹ Phipps and Cook, op.cit., p. 692.

² Snowden, Cook, and Walker, op. cit., p. 15.

nationally about 78 per cent of the farms were connected.¹ The rapid increase in the extension of distribution lines in Kansas since 1949 had brought electrical service to 92.4 per cent of the farms by 1954.²

The adaptation of electrical appliances manufactured primarily for urban use and the development of many new farm uses for electricity have made the farmer of today an electrical customer with a great electrical demand. In 1949, a survey of 284 farms in Southwestern Kansas showed the average annual consumption of electricity was 2,423 kilowatt-hours per farm. This was 1,100 kilowatt-hours more than the annual consumption in 1939 of 31 of these same farms.³

The use of electricity on the farm has become so common that the farmer has grown very dependent upon it. The extension of rural power lines has meant that more and more people on the farms could have running water, modern plumbing, adequate lights, and other electrical conveniences. Such developments have emphasized the need for increased mechanical abilities on the part of present and future farmers.⁴

The increase in consumption of electricity will undoubtedly continue on farms in Kansas. It has been estimated that by

¹ C. F. Bortfield and Joe F. Davis, Electricity on Farms in Southwestern Kansas, Kansas Agricultural Experiment Station Bulletin 351, p. 5.

² Kansas Inter-Industry Farm Electric Utilization Council, A Summary of Farm and Home Electric Equipment Used by Kansas Rural Residential and Farm Consumers and the Immediate Potential, p. 7.

³ Bortfield and Davis, loc. cit.

⁴ Edward O. Eaton, "Insurance for Electric Power," Agricultural Education Magazine, February, 1952, 24:188.

1960, farms in Southwestern Kansas will be using around 4,000 kilowatt-hours of electricity per farm per year, which is about 1,600 kilowatt-hours more than the average annual consumption of 1948.¹

In 1955, the Kansas Inter-Industry Farm Electric Utilization Council made a survey to determine the farm and home electrical equipment used by Kansas rural residential and farm consumers. A questionnaire was mailed to every tenth rural residential and farm consumer in Kansas who received service from the electric cooperatives and power companies. The questionnaire asked the consumers to indicate the appliances they had in the home and on the farm. They were also asked to list the next piece of electrical equipment they intended to purchase for the farm home and the next piece of electrical equipment to be purchased for use outside the home. A total of 10,739 questionnaires was mailed, and 10,181, or 94.8 per cent, were returned. The survey was completed in 103 of the 105 counties in Kansas.²

The percentage of farm equipment reported in this survey was considered conservative because rural residential as well as farm consumers were included in the survey base. Such rural residential users were those served on rural schedules and did not represent any substantial portion of the total.³

¹ Bortfield and Davis, op. cit., p. 7.

² Kansas Inter-Industry Farm Electric Utilization Council, op. cit., p. 4.

³ Loc. cit.

Results of the survey showed the percentage of people using the following major electrical household appliances:¹

<u>Equipment</u>	<u>Per cent</u>
Refrigerators	75.9
Conventional washers	75.3
Water systems	56.9
Television sets	40.1
Freezers	33.4
Electric ranges	31.3
Water heaters	22.0
Septic tanks	20.3
Room heaters	17.2
Window coolers	14.2
Window fans	14.1
Electric blankets	13.6
Automatic washers	12.6
Electric frying pans	7.5
Air conditions	6.1
Clothes dryers	4.1
Dish washers	2.6
Attic fans	2.5
Garbage disposals	0.6

The percentage of people surveyed using the following farm electrical equipment was as follows:²

<u>Equipment</u>	<u>Per cent</u>
Heat lamps	25.10
Hover-type brooders	15.10
Air compressors	15.10
Milking machines	13.30
Welders	12.80
Poultry lighting	12.00
Grain elevators	11.40
Milk coolers	4.77
Stock waterers	3.52
Dairy water heaters	2.20
Tank de-icers	1.80
Heating cables	1.75
Irrigation pumps	1.53
Feed grinders	1.26
Feed mixers	0.74
Poultry house ventilators	0.48

¹ Ibid., p. 8.

² Loc. cit.

<u>Equipment</u>	<u>Per cent</u>
Barn ventilators	0.48
Milkhouse heating	0.37
Silo unloaders	0.34
Barn cleaners	0.18
Grain dryers	0.18
Hay dryers	0.044

Poultry production, dairy operations, the farm shop, and grain handling indicated the greatest acceptance of the application of electricity to farm productive processes.¹

The ten uses of electricity reported most often were:²

<u>Equipment</u>	<u>5 Highest counties</u>	<u>5 Lowest counties</u>	<u>State average</u>
	Per cent	Per cent	Per cent
Heat lamps	48.6	7.9	25.1
Hover-type brooders	36.3	3.9	15.1
Air compressors	53.3	4.2	15.1
Milking machines	27.5	3.8	13.3
Welders	43.1	3.5	12.8
Poultry house lighting	30.9	2.6	12.0
Grain elevators	30.4	2.3	11.4
Milk coolers	15.5	1.1	4.8
Stock waterers	12.5	1.1	3.5
Dairy water heaters	15.7	0.6	2.2

The survey results indicated the "next unit of electric farm equipment costing more than \$64.00" that Kansas farmers intend to purchase would result in a multi-million dollar market.

The list included:³

<u>Equipment</u>	<u>Per cent</u>
Electric welders	33.0
Milking machines	16.1
Grain elevators	8.8
Milk coolers	7.1

¹ Ibid., p. 21.

² Loc. cit.

³ Ibid., p.29.

<u>Equipment</u>	<u>Per cent</u>
Air compressors	5.9
Irrigation systems	5.6
Stock waterers and tank de-icers	5.2
Feed grinders	4.4
Electric brooders or heat lamps	3.8
Silo unloaders	2.2
Feed mixers	1.9

The substantial interest in milk coolers, irrigation systems, feed grinders, feed mixers, and silo unloaders emphasizes the trend to more electric power for reducing human labor or for improving product quality.¹

The claims that by using electricity the costs of production are reduced, that the quality of farm products is improved, and that much of the drudgery of farm tasks is removed, seem justified.² Many new applications of electricity for light, heat, and power have been found useful on the modern farmstead. This is a true picture whether on a dairy, poultry, beef, or general farm.³ By compiling a list of the uses of electrical energy for light, heat, and power on the farm and in the home, little doubt is left in one's mind of how dependent the farmer has become on electricity.

Teaching Farm Electrification

Even though over 90 per cent of Kansas farms had electrical service in 1954, in many instances the applications of this

¹ Loc. cit.

² Eaton, loc. cit.

³ Loc. cit.

service were not extended beyond minimum home lighting. The training of farm people on how to utilize electricity economically and safely for family recreation, home conveniences, and farm work has been an almost untouched field.¹

Teaching farm electrification has presented the vocational agriculture teacher a challenging opportunity. T. J. Wakeman, Teacher Trainer in Farm Mechanics at Virginia Polytechnic Institute, made these observations regarding farm electrification:

We read and hear of the large percentage of farm families who have electrical service. However, very little has been said of the millions of inadequate wiring jobs; wiring which was just done. Not until recently when farmers really started to buy electrical equipment did they realize how inadequate and poorly planned their wiring was. Each time they added a piece of equipment they had to alter the wiring; add a larger fuse box, replace light wire with heavier wire, add circuits or maybe do a complete rewiring job.

Farmers realize their need for education on all phases of electricity and its application. Wiring is only one of the many problems they face. Thus, we should give them an over-all selection of jobs and let them choose the ones they think should be treated first.

Farm electrification should be analyzed into workable jobs just as any other farm enterprise. These jobs should be in the teacher's teaching calendar.²

A study was conducted in 1952 by Professor Clinton O. Jacobs, Assistant Teacher Trainer in Farm Mechanics, Kansas State College, to determine a basis for instructional planning in the area of farm mechanics for students of agriculture at Kansas

¹ Roland Harris, "Farm Mechanics Today," Agricultural Education Magazine, June, 1955, 27:267.

² T. J. Wakeman, "Teach Farm Electricity by Example and Demonstration," Better Farming Methods, May, 1951, 23:72-74.

State College. Although emphasis was placed upon studying the farm mechanics needs of college students in Agriculture, the study had implications for the evaluation and improvement of farm mechanics preparation of teachers of vocational agriculture, and course development and improvement in vocational agriculture for all-day students and young farmer groups.¹

Included in the six areas of the survey was Farm Power and Machinery, Farm Carpentry, Soil and Water Management, Rural Electrification, Water Supply and Sewage Disposal, and Farm Shop Work. The area of Rural Electrification showed approximately twice as many graduates desiring training in the job activities listed than any other area of farm mechanics except Farm Shop Work.²

The American Society of Agricultural Engineers' sub-committee on Agricultural Teacher Training has outlined objectives for each of the five areas of farm mechanics with suggestions of specific procedures which may be used. Although the report was primarily directed at teacher training education, it offers suggestions for the vocational agriculture teacher in the development of his teaching procedure. The suggested objectives and procedures for farm electrification were as follows:

¹ Clinton O. Jacobs, "Evaluation of Job Activities in Farm Mechanics," Agricultural Education Magazine, February, 1954, 27:177.

² Loc. cit.

A. Objectives

Develop understanding of basic principles involved, some judgment, and reasonable ability to:

1. Solve the common problems of wiring the farmstead and buildings: Present and future electrical loads, load center, distribution, pole location, wire sizes, service entrances, types of wiring, service outlets, switches, circuits, safety.
2. Select lighting equipment for yards, lots, and buildings, and other work areas: Kind, number, size, and location.
3. Select common electrical appliances and equipment for the farm and home: Safety; quality; energy consumption; durability; and provision for adjusting, cleaning, lubricating, and servicing.
4. Evaluate the use of electricity in productive farm enterprises and in the improvement of farm living conditions: Comparative costs; quality of product; savings in labor, health, sanitation, recreation.
5. Make suitable application of electric motors to various jobs: Types, sizes and characteristics of motors and drives; motor circuits, protective devices and switches, voltage.
6. Read meters, interpret rate schedules, and compute monthly bills.
7. Repair and maintain electrical equipment: Locating and correcting troubles and hazards, fuses, switches, fixtures, cords, and wiring, motors, heating appliances, lamps.

B. Some suggested procedures

1. Make sketches showing location of buildings on a selected farmstead. Estimate the connected load for each. Select location for distribution pole and lines to all buildings, and location of yard and lot lights, or do same thing using maps of selected farmsteads furnished by instructor.
2. Decide upon size of service entrances and distribution panels assuming certain lighting and appliance loads in all buildings and making provision for probable future expansion.

3. Figure size of wires between distribution pole and buildings.
4. Mark locations of switches, lighting fixtures, and appliance outlets on floor plans of houses, barns, shops, machine sheds, and other buildings.
5. Make inspection of good and poor wiring jobs of barns or other farm buildings, evaluating on a basis of what constitutes good practice.
6. Inspect and judge lighting in some rooms or homes and barns and other farm buildings, judging on a basis of what constitutes good practice.
7. Prepare a list from catalogs of lighting fixtures for various type rooms and buildings.
8. Compare two or more pieces of equipment, such as washing machines, refrigerators, or water pumps, and judge them on the safety, quality, durability, provisions for adjusting, cleaning, lubricating, etc.
9. Compute probable energy consumption of different appliances from nameplate data, or from tests.
10. Estimate the monthly cost of a farm water system, itemizing depreciation, interest, repairs, electricity, and labor.
11. Estimate the cost of brooding chicks, itemizing housing costs, brooder equipment costs, energy costs and labor costs, first by using electricity and then by using wood or oil brooders.
12. Estimate savings in chore labor by having water under pressure in barns, poultry houses, and lots.
13. Estimate costs of elevating hay, feed, or grain with electric equipment and by hand or with gas engine-driven equipment.
14. Estimate costs of grinding feed with electric-driven equipment and compare with costs of grinding at mill in town, or grinding at home with tractor-driven mill, or analyze other jobs or processes of local interest and importance.
15. Write a paper on possibilities of improving farm living conditions (health, sanitation, recreation, leisure) by use of electricity, or on some related topic.

16. Figure size of wires for one or more motors to specified jobs, using nameplate data.
17. Change connections on one or more motors to operate on different voltage (110 to 220 or 220 to 110).
18. Change direction of rotation on different types of motors.
19. Select belts and pulleys for given jobs, such as driving a feed grinder, or a barn hay finisher.
20. Make laboratory tests or observations on motor characteristics, such as starting current and starting torque.
21. Recommend proper type and size of motors together with suitable starting switches and overload protection for various jobs, such as driving washing machines, refrigerators, water pumps, elevators, bench grinders, hay finishers.
22. Determine energy consumption of several different motors and appliances by timing disk of watt-hour meter; also by use of voltmeter, ammeter, and wattmeter.
23. Compute probable cost of energy for a particular use, considering its place in the rate schedule.
24. Splice wires; connect wires to appliances, plugs, etc.; replace worn or damaged appliance cords.
25. Replace fuses, switches and outlets, using accepted safety methods.
26. Dismantle, clean, and make minor repairs to motors, including replacement of bearings and brushes, lubrication of bearings, and cleaning and dressing of commutators.
27. Locate troubles, such as short circuits, open circuits, and grounded circuits in appliances and wiring systems, using test lamp and prods or voltmeter.¹

¹ V. J. Morford, Methods of Teaching Farm Mechanics, p. 8-10.

The rapid progress of farm electrification in the last fifteen years has been of concern to teachers of vocational agriculture, agricultural engineers, and teacher trainers. The question usually asked is, "What should we teach and how much?" H. L. Price, Vocational Agricultural Teacher of Palmyra, Missouri, made these comments concerning farm electrification:

The coming of the R.E.A. offers a direct challenge to teachers of vocational agriculture. We know that most of our farm youth are practically in ignorance of the principles of electricity. We might argue that licensed electricians should do all the farmer's wiring. Yet we know that sooner or later the farmer will run a new wire or change an old one without calling the electrician. The need for training along these lines is probably more urgent than ever in our farm mechanics course.

Electrical power offers an entirely new field of opportunities in the farm mechanics course. Many teachers have avoided the use of power tools in farm shop work because it was impractical, since most of the students would never have the use of electricity after leaving school. Now complete modernization of the farmstead is in sight. Much of this change can only be accomplished through the farm youth.

Not only must we add new materials to our farm mechanics course, but also we must make major changes in our old material. For instance, most of us have included some pipe fitting work, but now we might include the farm water and sewage system. So if our farm homes are to be modern as city homes, we have work to do.

We will probably expect the student to become merely acquainted with some of the jobs to be taught, while there are others which he must master. This division will vary with the teacher's training, with the region, and with many other local factors.¹

The "what to teach" in such areas of farm mechanics as farm

¹ H. L. Price, "Planning Instruction in Rural Electrification," Agricultural Education Magazine, June, 1940, 12:235.

electrification is a difficult task according to Clyde Walker, Associate Professor of Agricultural Engineering, Oregon State College. He stated that:

The problem of the application or utilization for electricity about the farmstead is one which is never completely solved. By this I mean that new uses of electricity are continually being discovered, and farm families are discovering that, as they become familiar with electricity and its uses, they continually find additional ways in which it can be used. For these reasons, it is a subject that must remain open for consideration.

In addition to a study of applications and possible new uses for electricity on the farm, there is another general field of study which is also always in season: The problem of maintenance of electrical equipment which is being used. Electric motors need occasional attention. They should be cleaned and inspected periodically, lubrication checked, brushes inspected, and the commutator sanded or cleaned. Electric circuits should be inspected periodically to make sure that no conditions are developing which may result in a short circuit or other damage.

In connection with the problem of teaching farm electrification to high school students, I would like to suggest that it is a good idea to make sure that the students understand something of the principles of electricity before they attempt to use it extensively. I have noticed in some cases that one of the first things which instructors attempt to teach their students is something about electric wiring, yet it seems to me that it is foolish to do this before the student has some understanding of voltage and of the uses and abuses of the material with which he is dealing. The student who has no conception of electricity or how it should be handled is likely to be the one who takes short cuts on the wiring job, with possible dangerous results.

Another topic which should be emphasized in the minds of the students very early in the period is that of caution in the use of electricity.

They should be warned to always open a circuit before touching any point on the circuit or any appliances connected with it. Students should be drilled in this and similar precautions before they attempt very extensive work with electrical appliances.¹

¹ Clyde Walker, "Rural Electrification in Vocational Agriculture," Agricultural Education Magazine, July, 1941, 12:206.

Power suppliers in Kansas have been concerned with the ever-increasing problem of farm electrification. The Kansas Committee on the Relation of Electricity to Agriculture (C.R.E.A.), in cooperation with the Department of Agricultural Engineering, Kansas State College, has developed a demonstration board and demonstration manual.¹ Power suppliers throughout Kansas have purchased the demonstration boards and have made them available to vocational agriculture teachers on a loan basis. The demonstration board has been very well accepted for conducting classes and demonstrations on proper and safe wiring. The manual gives a practical explanation of electrical terms for the average everyday electrical consumer.² Also, the power suppliers have available lighting kits for demonstrating the effects of good and poor lighting.³

The vocational agriculture teacher has always been pressed for time and has not been able to cover all the material that the broad program of vocational agriculture demands. It has been indicated that the integration of farm electricity with all units of instruction in vocational agriculture would have distinct advantages. According to O. R. Johnson, integration has offered the following advantages:

¹ R. I. Lipper and Kenneth Harkness, Demonstration Manual for Teaching the Fundamentals of Farm Wiring, p. 46.

² The Thirty-first Annual Report of the Kansas Committee on the Relation of Electricity to Agriculture, p. 45.

³ A list of power companies which have demonstration boards and lighting kits available has been placed in the Appendix.

1. It correlates instruction.
2. It offers informative material in phases of farm mechanics that would otherwise be omitted.
3. It conserves the instructor's as well as the student's time.¹

The integration of farm electrification in the total vocational agriculture program is an area that offers opportunity for further study.

Students seem to learn best those things which they can directly relate to their own daily lives. Because electricity has become exceedingly important in many communities, students are faced with the hazards of electricity as soon as they are first exposed to its use. The use and hazards of electricity have been found in the environments of all students. Those few who did not have this source of power in their homes have made contact with it in many other locations. Emphasis should be given to the recognition and correction of hazards in the home electrical wiring. Students can be of service to their families by locating potential hazards for their parents.²

A need for teaching safety precautions in the use of electricity has been indicated by the installation and use of considerable electrical equipment by the farmers. Some of the safety measures considered in the electrical unit, as stated by Snowden, Cook, and Walker, are:

¹ Overton R. Johnson, "Integrating Electricity with Vocational Agriculture," Industrial Arts and Vocational Education, September, 1955, 44:205-206.

² Don E. Perry, "Organizing an Industrial Arts Course in Electricity," Industrial Arts and Vocational Education, March, 1955, 44:110-114.

1. Always wear rubber gloves when handling any kind of corrosive acids.
2. Be sure that all electrical equipment is properly grounded.
3. Do not cut toward the body when removing wire insulation.
4. Do not attempt to repair electrical appliances which are "hot".
5. Avoid using fuse substitutes; always use the proper size of fuse.
6. Follow the Electric Code when installing wire.
7. All electric wires should be considered "live" until proven otherwise - always play safe.
8. Use the correct kind of tools for the job to be done.
9. Do not attempt to do the job unless you are sure you know the correct procedure for doing it.
10. Avoid shocking another student.
11. Avoid looking at an electrical arc without protecting eyes.
12. Do not leave soldering coppers where someone will pick them up.
13. Always pull the switch or remove the fuse before working on a circuit.
14. Avoid handling electrical appliances when you are in a damp or grounded location.¹

"Electricity is one of the most dangerous units in the farm mechanics program, consequently every safety precaution should be taken to guard against any possible accident."²

"In God We Trust" was placed on pennies for people who placed pennies behind fuses.³ Pennies are placed behind fuses

¹ Snowden, Cook, Walker, op. cit., p. 409.

² Loc. cit.

³ E. F. Oliver, "The Farm Wiring Menace," Agricultural Education Magazine, January, 1955, 27:159.

because the wiring is too small to handle the load placed on it. The efficient use of electricity depends on a well planned, well installed wiring system that will take care of all present and future needs. The basic requirements of a well planned farm wiring system are that it be:

Safe - complying with the minimum standard of the National Electric Code.

Adequate - will handle the present and future needs.

Easily expanded - good planning and design will insure expansion.

Economical - A best-in-the-long-run installation.¹

"Wiring is something you pay for whether you get it or not" is a common statement that has been heard. If the wire size is too small, then the operating cost of electrical equipment is too high with the added possibility that the equipment may burn out or the wiring fail.²

H. H. London made the following statements concerning education in farm electricity:

Today, power lines are spread like a vast spider web over rural America, bringing modern conveniences, relief from drudgery and more efficient operation to hundreds of thousands of farm homes. But the job of electrifying the rural homes of the nation is by no means complete. Neither has effective use been made of electricity by many farm families who now have this service.

Improved use of electricity on the farm involves, in some places at least, additional lines and appliances, more adequate and regular current supply, and the training of workmen for the better installation and care of equipment. The crux of the matter, however, seems to be the education of farm families themselves

¹ Loc. cit.
² Loc. cit.

in the use of electricity, what it can do for them, how to select and install equipment, and how to operate and care for it. This is the problem that confronts the R.E.A. Cooperatives throughout the country in their efforts to expand and improve their services. It is likewise a major problem for the many educational agencies, including vocational agriculture, which are at work to raise the standard of living among rural people.¹

Organization of Course Content

Vocational agriculture teachers start with the individual where he is, as far as previous experiences are concerned, and move him through functional systematic instruction and guidance to a satisfactory level for the farming situation involved. Therefore it is essential that the vocational agriculture teacher, along with assistance from the students in vocational agriculture, and others affected by the plan, develop a course of study. Preliminary planning of a course of study is an attempt to use what is known about a community to anticipate what will need to be taught.² In deciding what to teach in farm mechanics, first consideration must be given to the interests, needs, and abilities of the students. The development of effective abilities in farm mechanics for present and prospective farmers is the primary objective of the instruction. Therefore a student should receive the type of training which would prepare him to perform the farm mechanics jobs he would do as a progressive

¹ H. H. London, "Education - The Key to Improved Use of Electricity on the Farm," Agricultural Education Magazine, April, 1949, 25:196.

² Snowden, Cook, and Walker, op. cit., p. 11.

farmer in his community with the kind of tools and equipment he has available.¹

When deciding what to include in the course of study, the teacher must think carefully through the reasons for offering the instruction and outline the objectives. The objectives should be based upon individual needs and in terms of abilities which the students can hope to achieve. The objectives of an organized course of study contribute to the objectives of the department, which in turn contribute to the overall objectives of general education, vocational education, and agricultural education.²

Cook, Walker, and Snowden suggested the following objectives for farm electrification:

1. Ability to increase farm income by properly using electricity.
2. Ability to understand basic principles of electricity.
3. Ability to understand the common electrical terms.
4. Ability to select wiring equipment and appliances.
5. Ability to plan a system of wiring the farmstead.
6. Ability to develop a general understanding of how a building should be wired - evaluate the work done.
7. Ability to use necessary precautions in maintaining an electrical system.
8. Ability to do the ordinary wiring and repair jobs on the farm.
9. Ability to develop the ideal of keeping all electrical appliances in good condition.

¹ Phipps and Cook, op. cit., p. 689.

² Ibid., p. 176.

10. Ability to properly care for and maintain electric motors.
11. Ability to construct suitable electrical equipment.
12. Ability to use safety precautions.
13. Ability to calculate electrical consumption and cost.¹

In determining the objectives and activities to include in a course of study, it is important that the community be studied thoroughly.² Available data as census reports and departmental records should be studied. A survey of the home farms of students may be necessary and is advisable. This study should reveal the following:

1. Basic information about the farms including size and types of farming operation.
2. Kind of farm machinery used on the farms.
3. Mechanical activities of the farmers.
4. Tools and equipment in home farm shops.
5. Kinds of construction or repair projects done on the farm.
6. Home conveniences on the farms.
7. Labor-saving devices being used.³

A number of activities in farm mechanics for which training is needed should result from the study of the summary of such a survey.

A vocational agriculture teacher should do considerable planning of the course content with all persons affected by the plan. Those most affected by a plan should be brought into the

¹ Snowden, Cook, and Walker, op. cit., p. 244-246.
² Phipps and Cook, op. cit., p. 64.
³ Ibid., p. 698.

planning early. This would include the administrators, persons enrolled in vocational agriculture courses at all levels, parents, and other teachers.¹

The phases to include in a course of study of farm electrification should be based upon the facilities available, the qualifications of the instructor, the amount of time devoted to farm mechanics, and the interests, needs, and abilities of the pupils.²

PROCEDURE AND TREATMENT OF DATA

Procedure

The data used in this study was secured by the survey-questionnaire method.³ A list of vocational agriculture teachers was obtained from the Vocational Education office at Kansas State College. Three of every four teachers on the list were mailed two questionnaires each. The 150 teachers were requested to distribute the questionnaires to two young farmers in their community who had received vocational agriculture instruction in high school and were presently farming. Of the 300 questionnaires distributed, 104, or 34.7 per cent, were completed and returned. The returned questionnaires represented 78 communities served by vocational agriculture departments.

¹ Ibid., p. 62.

² Ibid., p. 703.

³ A copy of the questionnaire has been placed in the Appendix.

The farmers surveyed were asked to evaluate selected job activities in seven areas of farm electrification, namely: (1) Fundamentals of electricity, (2) Electrical safety, (3) Electrical skill, (4) Planning the electrical system, (5) Electrical farm equipment, (6) Electric motors, and (7) Farm conveniences. Evaluation was based upon the farmers checking one of the following categories which most nearly described their need for the job activity in question: (1) Perform when necessary; (2) If trained would do; (3) Prefer to hire done; and (4) Have no need for this job.

Treatment of Data

To establish educational significance to the replies of the survey, it was assumed that a certain percentage value of the total number of checks in a particular category be equaled or exceeded. The following method was used to determine the educational significance of an activity:

1. If the percentage values of categories I (Perform when necessary) and II (If trained would do) totaled 80 per cent or more, a "total need" for either continued or increased emphasis on the particular job activity would be suggested.

2. The desire to receive training was implied in category II (If trained would do). If 50 per cent or more checked this category, it was assumed that increased emphasis should be placed on instruction in that activity.

3. A graduate may have checked category III (Prefer to hire

done), which indicated a need existed for doing the activity on the farm, but because of the requirement of technical training, special tools, etc., he preferred to hire this job done. Because the job was more often hired done, it was decided that even though the need for performing the job activity existed, less immediate emphasis should be placed upon its educational significance from the standpoint of desire and performance by the farmer. It was therefore assumed that if the percentage value of a certain activity in category III (Prefer to hire done) and category IV (Have no need for) totaled 30 per cent or more, less significance should be attached to its immediate attention in a program of instruction in farm electrification.

If a job activity did not show a "total need" of 80 per cent and did not indicate a "desire for training" of 50 per cent, it was assumed that less immediate emphasis should be placed upon its educational value from the standpoint of desire and performance by the farmer.

The job activities in the survey were summarized into the following phases of electricity:

1. Fundamentals of electricity
2. Electrical safety
3. Electrical skills
4. Planning the electrical system
5. Electrical farm equipment
6. Electric motors
7. Farm conveniences

RESULTS

The challenge has been to teach the future, young, and adult farmer the proper planning, selection, installation, and maintenance of the farm wiring system and electrical equipment, as well as the productive application of electricity in the farming operations.

Before a vocational agriculture teacher can develop a course of study, he has to know several factors about the community in which he is teaching. As indicated by the survey of related literature, the needs of the student and communities are included in the basic information required by the teacher. A knowledge of the existing need for instruction in farm electrification is necessary before the course of study in farm electrification can be outlined and organized into teaching units.

Table 1 is presented to show the summary of the replies received from farmers who have received vocational agriculture training in high school. A breakdown by phases of electricity, as to the total replies in each phase, as well as the average per cent of the total replies for each of the four categories, is presented.

It is noted that in the area of fundamentals of electricity, 45.1 per cent desired training, and 38.9 per cent performed the job activities listed under this phase. This indicated an expressed total need for fundamentals of electricity of 84 per cent.

Ninety-one per cent of the replies expressed a total need

Table 1. Summary by phases of farm electrification with respect to the replies of farmers who indicated have performed, desire training, prefer to hire, or have no need for doing the job activity.

Phase of electricity	(I)		(II)		(III)		(IV)	
	Perform when necessary		If trained would do		Prefer to hire done		Have no need for	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Fundamentals of electricity	485	38.9	563	45.1	143	11.5	57	4.5
Electrical safety	847	54.3	572	36.7	124	7.9	17	1.1
Electrical skills	625	54.6	387	33.9	102	8.9	30	2.6
Planning the electrical system	519	35.7	698	47.9	171	11.7	68	4.7
Electrical farm equipment	845	54.2	428	27.4	109	7.0	178	11.4
Electric motors	485	42.4	489	42.7	131	11.5	39	3.4
Farm conveniences	285	45.7	228	36.5	67	10.7	44	7.1
TOTAL NUMBER CHECKS	4091		3365		847		433	
Average per cent (all groups)		46.9		38.5		9.7		4.9

for electrical safety. It is therefore evident that the farmers are aware of the necessity for safety and thought it was an important part of instruction in electricity.

Electrical skills were performed by 54.6 per cent while 33.9 per cent desired training in the skills. This indicated a total need of 88.5 per cent. Only 8.9 per cent preferred to hire the job done, and 2.6 per cent stated they had no need for the jobs.

Of the job activities listed under Planning the Wiring System, 47.9 per cent desired training in the jobs, and 35.7 per cent indicated they performed the jobs. However, 11.7 per cent of the replies indicated they preferred to hire the planning phase done.

The use of electrical farm equipment was indicated by 54.2 per cent, and desire for training was indicated by 27.4 per cent. Part of this low per cent to total need (81.6 per cent) was due to the indication that 11.4 per cent had no need for the listed electrical equipment on their farm. This was assumed to be related to the type of farming in a given area, since some types of farming enterprises adapt themselves readily to the extensive use of electricity, while others do not.

A total need of 85.1 per cent was indicated for the job activities under the phase electric motors. This area showed the highest preference to have the job activities hired done.

Farm conveniences indicated a total need of 82.2 per cent, with 45.7 per cent performing the job activities and 36.5 per cent desiring training.

Since the farmer must obtain his skill and knowledge of electricity from some type of instruction, the inclusion of instruction in farm electrification in the vocational agriculture program is one means of filling this need for the present and future farmer.

Total Need for Training in Farm Electrification

From the survey, 85.4 per cent of the farmers reporting indicated an average total need for instruction in farm electrification. The job activities in which a total of 80 per cent or more indicated a total need for instruction were as follows, in the order of need:

Replace blown fuses with proper size fuse and/or reset circuit breaker	100.0
Repair extension cords	100.0
Use operator's manual to install and maintain equipment purchased	98.1
Replace outlets, switches, or light fixtures	97.1
Locate lighting fixtures to best advantage	97.1
Select proper size pulleys for speed desired	96.2
Locate switches and outlets for convenience and safety	95.3
Splice electric wire	94.3
Determine reason for fuse blowing or multibreaker tripping	94.2
Select fixtures suitable and safe for the job	93.3
Protect pump and pipes from freezing during winter	93.3

Make electric motors portable	91.3
Use equipment ground on electric drills and other electric equipment	91.3
Install outdoor lighting when required	90.6
Determine correct size and type of motor for a given job	90.4
Figure cost of electricity used per month by reading meter	89.4
Provide proper motor protection by the use of fuses and circuit breaker	89.4
Use electric welder for repair jobs	89.4
Select proper wiring materials for the job	89.4
Rearrange indoor lighting to meet present and future needs	88.5
Determine wire sizes to be used for a given load	88.5
Adapt present farm equipment to electric motor operation	88.4
Clean and lubricate electric motors properly	88.4
Install new wiring, switches, and convenience outlets	88.4
Determine kind and number of switches and outlets for each building	87.6
Compute operating cost of electrical equipment	86.5
Use electric grain elevators, grinders, and/or mixers	83.7
Reverse electric motors	83.7
Plan new wiring to meet the future needs	82.6
Install three- and four-way switches	80.8
Plan and build electric brooding equipment for chickens, pigs, or lambs	80.8
Select correct type of water pump to meet needs	80.8

Desire for Training in Farm Electrification

The desire for training was believed to have been indicated in the category "if trained would do". It was assumed that if 50 per cent or more of the farmers reported this desire, the need for increased emphasis in the area was implied. In order of desire for training, the following job activities were indicated.

Install three- and four-way switches	67.3
Determine voltage drop and its effect on lights and equipment	66.3
Determine wire sizes to be used for a given load	65.4
Locate causes for motor overheating	62.5
Balance the load on a 3-wire, 115/230-volt system	62.4
Compute operating cost of electrical equipment	59.6
Select proper wiring materials for the job	57.6
Correct motor troubles as bearings, overheating, and failure to start	54.8
Check and evaluate existing wiring circuits	51.9
Reverse electric motors	50.0
Connect and use timing devices for turning on lights and motors	50.0
Rearrange indoor lighting to meet present and future needs	50.0

Less Immediate Need for Training

Thirty per cent or more of the farmers indicated less immediate need for the job activities when category III (Prefer to hire done) and category IV (Have no need for) were added together:

Provide adequate cooling for milk and eggs by refrigeration	46.1
Construct hay and grain drying equipment	39.4
Use remote control switches where possible	32.7
Check and evaluate existing wiring circuits	30.8

It was assumed that less immediate need existed for training in the following job activities that did not show a total need or a desire for training:

- Provide adequate cooling for milk and eggs by refrigeration
- Construct hay and grain drying equipment
- Use remote control switches where possible
- Locate wiring troubles
- Install and use water warming devices for livestock and poultry
- Select correct size pump and motor for a water system
- Plan a water system for a farm.

Summary of the Results

Before a farmer attempts to utilize electricity extensively, he should understand some of the fundamentals of electricity.

The lack of knowledge concerning electricity or how it should be handled may cause short cuts with possible dangerous results. Several references used in the survey of literature suggested that students be instructed in the principles of electricity before performing wiring operations.

The results of the survey conducted for this study indicated that 84 per cent of the farmers realized the importance of the fundamentals of electricity. Including instruction in the fundamentals of electricity in the course of study in farm electrification should prepare the students for a more intensive use of electricity.

Another phase of electricity that should be included in the course of study and emphasized in the minds of students early in the instruction is caution in the use of electricity. It has been said that electricity is one of the most dangerous units in the farm mechanics program. The farmers surveyed indicated they were aware of the need for continued and increased emphasis on safety.

The extension of electricity to the farms throughout Kansas has emphasized the need for increased mechanical abilities on the part of present and future farmers. The most important part of the vocational agriculture student's training is the application or doing step in each job. Before a student can put into practice certain jobs on the home farm, he must develop skill in the performance of these jobs.

The total need for the ability to perform electrical skills in farm electricity was indicated by 88.5 per cent of the farmers

who replied. It was therefore considered important that the instruction in electrical skills be included in the course of study.

As the farms have become modernized electrically, many new electrical appliances and new equipment have been purchased. The survey of literature indicated that there would be an increase in the use of electrical equipment in the future. However, many farmers do not realize how inadequate and poorly planned their wiring is until they begin to use more and more electrical equipment. Each time a new piece of equipment is added, they alter the wiring, add a larger fuse box, replace small wire with large wire, or do a complete rewiring job. The correct practice would be to plan the wiring installations to take care of probable future demands.

Planning the electrical system was indicated as the phase of electricity that the largest percentage (47.9 per cent) of the farmers felt they needed training in. It therefore indicated that this phase of electricity should be included in a course of study in farm electrification.

The problem of maintenance of electrical equipment used on the farm is continuous. Electric motors should be cleaned, inspected, and lubricated periodically. It is therefore important that instruction in electrical farm equipment and farm motors form a part of the instructional program of farm electrification. This is further emphasized by the state-wide survey, quoted in the survey of literature, of the trend in Kansas toward the use of more electrical power for reducing human labor and for

improving product quality.

The indications are that farm people are interested in making their homes comfortable and convenient before using electricity in the farming operations. As indicated by the replies from the survey of farmers, 82.2 per cent felt a total need for continued or increased emphasis in the phase of farm conveniences.

An organized course of study in vocational agriculture that will meet the needs of the local community and the course organization of the teacher should include the areas of electricity as indicated by the results of this study.

The "how to teach" farm electrification to high school students has been a problem confronting the vocational agriculture teachers. As indicated previously, the use of the demonstration board and manuals, distributed by the Kansas Committee on the Relation of Electricity to Agriculture, has been considered successful.

Instructional lesson plans and operational job sheets in farm electrification could also be used for instruction by vocational agriculture teachers. This was indicated by an inquiry, conducted under the supervision of Professor Ralph I. Lipper, Department of Agricultural Engineering, Kansas State College, of the vocational agriculture teachers who attended the annual teachers' conference, June 5-8, 1956. Approximately 85 per cent of the 123 teachers questioned indicated they could improve their instruction by the selective use of prepared lesson plans and

job sheets.¹

It was with this premise and based upon the results of the survey of high school graduates now farming, that the proposed course of study and suggested instructional lesson plans and operative job sheets were developed.

SUMMARY

Electrical service has become available to nearly all of the farms in Kansas within the past decade. The rapid extension of distribution lines in Kansas had brought electrical service to 92.4 per cent of the farms by 1954. Being available to practically everyone and so generally accepted, electricity has become increasingly important. The adapting of electrical appliances manufactured primarily for urban use and the development of many new farm uses for electricity, has made the farmer of today an electrical customer with a great electrical demand. It has been estimated that by 1960, farms in Southwestern Kansas will be using 4,000 kilowatt-hours of electricity per farm per year.

There is evidence that the trend on Kansas farms is toward using more electric power for reducing human labor and improving product quality. The training of farm people on how to utilize electricity economically and safely remains almost an untouched

¹ Ralph I. Lipper, unpublished material, Department of Agricultural Engineering, Kansas State College, June 8, 1956.

field. Teaching farm electrification presents the vocational agriculture teacher with a challenging opportunity. However, the teacher's decision of "what to teach" in farm electrification has been a difficult task. The interests, needs, and abilities of the students, the facilities available, the qualifications of the instructor, and the amount of time devoted to farm mechanics have all influenced the phases to include in teaching farm electrification.

The preliminary planning of course content is an attempt to use what is known about a community to anticipate what will need to be taught. Therefore in deciding what to teach, first consideration must be given to the interests, needs, and abilities of the student.

The survey questionnaire was used to determine the phases of electricity that graduates of high school who were farming felt should be included in the vocational agriculture program.

The results of the survey indicated that the farmers had a total need for instruction in the following phases of electricity: Fundamentals of electricity; electrical safety; electrical skills; planning the electrical system; electric farm equipment; electric motors; and farm conveniences.

From the above phases of farm electrification, a proposed course of study and suggested instructional lesson plans and operative job sheets were developed. Although not expected to be adapted by all vocational agriculture teachers in Kansas, they do suggest a method of selection and organization of subject matter. The lesson plans and job sheets will not fit every

situation and will have to be modified by each teacher to meet his particular need and the need of the students. In addition, specific references are given for each lesson plan and job sheet to help the instructor and students in preparation for the class lesson.

It is expected that the proposed course of study and suggested instructional lesson plans and operative job sheets will be of value to teachers of vocational agriculture, and especially to the inexperienced teachers who are beginning their work in the vocational agriculture profession in Kansas.

CONCLUSIONS

The vocational agriculture teacher is responsible for outlining and organizing the teaching program in vocational agriculture in his community. The teaching program should be flexible, adjustable, and based upon the needs of the students. Before the agriculture teacher can proceed to determine course content, he must acquaint himself with the type of farming in the community, the needs of the all-day, young, and adult farmer students, and the facilities of the farms from which the class members come.

Evidence points to the fact that farm electrification should be included in instruction in vocational agriculture in Kansas. The importance of electricity is indicated by the fact that (1) 92.4 per cent of the farms in Kansas are using electricity, and (2) the trend is toward using more electrical power to reduce

human labor and improve product quality.

Although electricity is a highly technical and scientific subject, it is necessary that individuals using electricity have a basic knowledge of how it functions and the equipment it can operate.

The objective of mechanical training in Vocational Agriculture is to train present and prospective farmers to do the unspecialized mechanical jobs connected with their farming program. Thus a general course in farm electrification, covering those phases of electricity necessary for the farmers to supervise, operate, maintain and repair their electrical system and equipment, should be included in the vocational agriculture program.

There is much to be done in vocational agriculture relative to farm electrification. The job, if properly done, will yield great dividends in safety, convenience, and profits to farmers of Kansas. In many cases, this may mean additional training for the vocational agriculture teacher and the reorganization of his course offerings to allow for a greater emphasis on farm electrification.

Based upon the results of the survey, a proposed course of study and suggested instructional lesson plans and operational job sheets in farm electrification have been prepared. It is believed that through the selective use of this material, the vocational agriculture teacher will be assisted in the organization of subject matter to meet the individual and class needs.

Proposed Course of Study and Suggested
Lesson Plans and Job Sheets for Farm Electrification

The proposed course of study in farm electrification has been distributed over four years of instruction in vocational agriculture. The course of study was divided into job activities and skills to be acquired, for each of the four years. The course of study was carried further by the development of suggested lesson plans and job sheets. These lesson plans and job sheets were arranged according to the proposed course of study for each of the four years of instruction in farm electrification. The job activities were organized in the following manner: Enterprise, job, objectives, equipment and material, references, operation procedure (for job sheets only), questions for study, and teaching procedure.

The lesson plans and job sheets were prepared to serve as a guide in selecting and organizing subject matter in the area of farm electrification. They will also provide a basis and a source of material for preparing the students to analyze the problems encountered in farm electrification.

Vocational Agriculture I Proposed Course of Study

<u>Job activity</u>	<u>Skills to be acquired</u>
1. Figure cost of electricity used per month.	a. Familiarization with electrical terms. b. Read electric meter. c. Application of kilowatt-hour meter. d. Familiarization with local rate schedule. e. Calculate electric bill.
2. Repair and make extension cord.	a. Safety precautions. b. Removing insulation properly. c. Forming terminal eye. d. Underwriters' knot.
3. Splice electric wire.	a. Familiarization with types of splices. b. Removing insulation properly. c. Soldering splice properly. d. Proper use of rubber, friction, and plastic tape coverings. e. Safety procedures.

Vocational Agriculture I Proposed Course of Study (Con't.)

<u>Job activity</u>	<u>Skills to be acquired</u>
4. Study of fuses and circuit breakers.	<ul style="list-style-type: none"> a. Learn type of fuses. b. Proper use of fuses. c. Locating causes of fuses blowing. d. Ability to select proper size and type of fuse e. Safety precautions.
5. Study of voltage drop and its effect.	<ul style="list-style-type: none"> a. Learn effects of voltage drop. b. Causes of voltage drop. c. Ability to reduce voltage drop. d. Safety.

Vocational Agriculture I Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Figure cost of electricity used per month.

Objectives:

1. Familiarization with electrical terms.
2. Understand the application of a kilowatt-hour meter.
3. To develop ability to figure a monthly electric bill.

Equipment and materials:

1. Kilowatt-hour meter.
2. Rate schedule of local power company.
3. Demonstration board.

Vocational Agriculture I Suggested Lesson Plan (Con't.)

References:

1. Wiring Simplified, by Richter, p. 19-21.
2. Farm Mechanics Text and Handbook, by Phipps, McColly, Scranton, and Cook, p. 621-625.
3. Demonstration Manual, Kansas C.R.E.A., Demonstrations 1, 2, and 3, p. 1-13.

Questions for study:

1. Define the following electrical terms:
 - a. Volt
 - b. Ampere
 - c. Watt
 - d. Watt-hour
 - e. Kilowatt
 - f. Kilowatt-hour
2. What is the purpose of a kilowatt-hour meter?
3. Determine the monthly bill, if the meter reading at the beginning of the month is 4902 and at the end of the month the reading is 5266. Either use the local rate schedule or the following rate schedule:

First 60 kw-hr used per month ----- 6¢ per kw-hr
 Next 40 kw-hr used per month ----- 3¢ per kw-hr
 All over 100 kw-hr used per month -- 2¢ per kw-hr
4. How is the kilowatt-hour meter used to determine the power requirements of various equipment?

Teaching procedure: Present demonstrations 1, 2, and 3 of the K.C.R.E.A. Demonstration Manual.

Vocational Agriculture I Suggested Job Sheet

Enterprise: Farm electrification.

Job: Repair and make extension cord.

Objectives:

1. Learn how to tie an Underwriters' or holding knot.
2. Learn how to remove insulation from wires correctly.
3. Learn how to bend leads to be placed under terminal screw.
4. Apply this knowledge to repairing and making extension cords.
5. Learn safety procedures.

Equipment and material:

1. Two-conductor wire of desired length and size.
2. Male and female plugs.
3. Extension cord that needs repairs.
4. Small screw driver.
5. Knife or wire stripper.
6. Needle nose pliers.
7. Test light.

References:

1. Wiring Simplified, by Richter, p. 29-31.
2. Farm Mechanics Text and Handbook, by Phipp, McColly, Scranton, and Cook, p. 639-640, 655.

Vocational Agricultural I Suggested Job Sheet (Con't.)

Operation procedure:

<u>Steps</u>	<u>Key points</u>
1. Connect male plug to cord	
a. Remove 1-1/2 inches of the outside insulation from one end of the cord.	1. Be careful not to cut primary insulation covering individual wires.
b. Remove 3/4 inch of primary insulation from each individual wire.	1. Be careful not to cut the small wires.
c. Cut the small threads off at the end of the rubber insulation.	
d. Twist the copper strands.	
e. Remove the inner part from the shell if the plug is in two parts.	
f. Thread cord through hole in plug.	
g. With needle nose pliers, bend the bare wire into a loop.	1. The secondary insulation should extend well into the plug and the primary insulation should extend to the screw.

Vocational Agriculture I Suggested Job Sheet (Con't.)

<u>Steps</u>	<u>Key Points</u>
<p>h. Loosen terminal screws and insert white wire under silver terminal.</p>	<p>1. Be sure that when the screw is tightened, the wire will tighten around the screw.</p> <p>2. Silver - ground wire.</p> <p>3. Brass - hot wire.</p>
<p>i. Place paper disk over prongs.</p>	
<p>2. Connect female plug to socket.</p>	
<p>a. Remove 3 to 4 inches of secondary insulation from other end of cord.</p>	<p>1. Be careful not to cut wire.</p>
<p>b. Disassemble plug.</p>	
<p>c. Place cord through plug.</p>	
<p>d. Tie an Underwriters' knot at the end of the secondary insulation.</p>	<p>1. Follow directions as demonstrated.</p>
<p>e. Remove 3/4 inch of primary insulation from end of each wire.</p>	
<p>f. Place each wire under terminal as in Step "h".</p>	
<p>g. Put plug together and bring to instructor for checking and testing.</p>	

Vocational Agriculture I Suggested Job Sheet (Con't.)

Safety precautions:

1. Do not plug into any kind of outlet while working on the cord.
2. Make sure there are no shorts in the extension cord.
3. Use caution with knives.
4. Tighten all screws.
5. Attach wires to terminals in correct way.

Questions for study:

1. What is an extension cord? Where are they used?
2. What should be kept in mind when selecting the material for extension cords?
3. Why are stranded wires used in extension cords?
4. How should the cord be properly removed from an outlet?
5. What is the difference between the silver and brass terminals?
6. What features should a person look for in selecting a good male plug?

Vocational Agriculture I Suggested Job Sheet

Enterprise: Farm electrification.

Job: Splicing electrical wire.

Objectives:

1. Learn the different types of splices and their application.
2. Ability to remove insulation from wires properly.
3. Ability to solder wire properly.
4. Ability to use rubber and friction tape properly.
5. Ability to recognize safety precautions.

Vocational Agriculture I Suggested Job Sheet (Con't.)

Objectives (Con't.):

6. Ability to apply acquired skills to home situation.

Equipment and material:

1. Electric wire
2. Knife
3. Pliers
4. Soldering iron
5. Rosin-core solder
6. Rubber tape
7. Friction tape
8. Test lamp.

References:

1. Farm Mechanics Text and Handbook, by Phipps, McColly, Scranton, and Cook, p. 313, 640-641.
2. Wiring Simplified, by Richter, p. 31-33.

Operation procedure:

<u>Steps</u>	<u>Key points</u>
1. Western Union splice	
a. Remove about 3 inches of insulation from ends of wires.	1. Do not nick wire.
b. Clean wires by scraping with a knife.	1. Must be clean for solder to bond.
c. Make a right angle bend about two inches from end of each wire.	

Vocational Agriculture I Suggested Job Sheet (Con't.)

Operation procedure (Con't.)

- | | |
|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| d. Hold wires tightly together with pliers at joint. Wrap loose ends to form splice. | 1. Each end should be wrapped at least four times. |
| e. Bend ends of wire down snugly to prevent puncture of insulation. | |
| f. Solder joint with non-corrosive flux and solder. | 1. Heat wire until it melts the solder. |
| g. Wrap with rubber tape, lapped over original insulation. | 1. Rubber tape as thick as original insulation.
2. Keep tight at all times. |
| h. Place a layer or two of friction tape over this. | 1. Binds rubber tape and acts as tough outer layer. |
|
2. Rattail splice | |
| a. Remove one inch of insulation. | 1. Do not nick wire. |
| b. Clean wires by scraping with knife. | |
| c. Place bare wire parallel and twist together. | 1. Twist tightly. |
| d. Follow steps "e" through "h" of above procedure. | |

Vocational Agriculture I Suggested Job Sheet (Con't.)

Safety precautions:

1. Do not plug wire into any kind of outlet while working.
2. Use non-corrosive flux.
3. Use caution with knives.
4. Apply rubber tape first, then friction tape.
5. All bare wires must be covered with insulation.

Questions for study:

1. List the type of splices and their uses.
2. What type of connectors can be used instead of the rattail splice?
3. What type of flux is used for soldering electrical connections? Why?
4. How is the splice soldered?
5. Name the types of tapes used on a splice.

Vocational Agriculture I Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Study of fuses and circuit breakers.

Objectives:

1. Learn how fuses operate.
2. Familiarization with the proper use of fuses.
3. Familiarization with the different types of fuses.
4. Ability to locate causes of fuses blowing.
5. Ability to select proper size and type of fuse.

Equipment and materials:

1. Assortment of plug, cartridge, and delayed-action fuses.
2. Multibreaker

Vocational Agriculture I Suggested Lesson Plan (Con't.)

Equipment and materials (Con't.)

3. Test lamp.
4. Demonstration board and equipment.

References:

1. Electricity in the Home and on the Farm, by Wright, p. 253-275.
2. Wiring Simplified, by Richter, p. 34-36.
3. Demonstration Manual, Kansas C.R.E.A., Demonstration No. 4, p. 14-16.

Questions for study:

1. What is the purpose of fuses in electric circuits?
2. What types of fuses are commonly used? Give examples of use.
3. Explain how a fuse works.
4. How should one proceed to locate the cause of a "blown" fuse or tripped multibreaker?
5. What is meant by overfusing a circuit?
6. What causes a fuse to blow?
7. Explain correct procedure for renewing a fuse.
8. Demonstrate why a fuse will blow and how to locate a blown fuse with test lamp.
9. What type of fuse should be selected for a circuit carrying 30 amperes at 115 volts?

Teaching procedure: Present demonstration No. 4, K.C.R.E.A.

Demonstration Manual.

Vocational Agriculture I Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Study of voltage drop and its effect.

Objectives:

1. Understand the importance of voltage drop.
2. Understand the causes of voltage drop.
3. Understand ways to reduce voltage drop.
4. Understand effects of voltage drop on lights and equipment.

Equipment and material: Demonstration panel.

References:

1. Demonstration Manual, Kansas C.R.E.A., Demonstration No. 5, p. 17-19.
2. Wiring Simplified, by Richter, p. 24-26.
3. Electricity in the Home and on the Farm, by Wright, p. 23-25, 42-44, 318-325.

Questions for study:

1. What is voltage drop?
2. Give two reasons why voltage drop is undesirable.
3. What happens to electrical energy lost through voltage drop in circuit wires?
4. How can serious voltage drops be avoided?
5. List three causes of voltage drop.

Teaching procedure: Present demonstration No. 5, of K.C.R.E.A. Demonstration Manual.

Vocational Agriculture II Proposed Course of Study

<u>Job activity</u>	<u>Skills to be acquired</u>
1. Compute operating cost of electrical equipment.	a. Familiarization with electrical terms. b. Ability to use watt-hour meter for measuring costs. c. Compute cost of using electrical equipment.
2. Determine wire sizes.	a. Principles of economical and safe wiring. b. Understand effects of inadequate wire size. c. Ability to select correct wire size. d. Understand National Electric Code.
3. Selecting wiring material.	a. Learn types of wiring material. b. Select wiring material. c. Identify wiring material. d. Use of the National Electric Code.
4. Location of switches and outlets.	a. Familiarization with National Electric Code. b. Location for convenience. c. Safety requirements.

Vocational Agriculture II Proposed Course of Study (Con't.)

<u>Job activity</u>	<u>Skills to be acquired</u>
	d. Number of outlets for given building.
5. Replace single-pole switch.	a. Select proper switch. b. Replace switch. c. Underwriters' Laboratory label. d. Safety precautions.
6. Determining size of pulleys to use.	a. Correct equipment speed. b. Determine pulley sizes. c. Types of pulleys and belts.
7. Making a small motor portable.	a. Economical use of motors. b. Apply previously learned skills. c. Select correct pulley size.
8. Familiarization with electric welders.	a. Types of welders. b. Operating principles. c. Maintenance.
9. Adapting present farm equipment to electric motor operation.	a. Apply motors to the farm. b. Determine correct operating speeds. c. Estimating operating cost. d. Advantages of electric motors.

Vocational Agriculture II Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Compute operating costs of electrical equipment.

Objectives:

1. Review of electrical terms.
2. Develop ability to compute operating cost of electrical equipment.
3. Ability to use the watt-hour meter in measuring power requirements.

Equipment and material:

1. Demonstration panel.
2. Kilowatt-hour meter.

References:

1. Demonstration Manual by the K.C.R.E.A., Demonstrations No. 2 and No. 3.
2. Electricity in the Home and on the Farm, by Wright, p. 304-313.
3. Wiring Simplified, by Richter, p. 19-21.

Questions for study:

1. Define the following electrical term: Volts, ampere, watt, watt-hour, kilowatt, and kilowatt-hour.
2. What is the purpose of a kilowatt-hour meter?
3. What is a meter disk constant?
4. Outline procedure for measuring the power requirements of an appliance.
5. What wattage is drawn by an appliance that turns the meter disk 20 rpm., if the disk constant is 0.5?

Vocational Agriculture II Suggested Lesson Plan (Con't.)

Questions for study (con't.):

6. A dairy water heater is rated at 1000 watts. It is used for 2 hours per day at a rate of 1.5 cents per kilowatt-hour. What is the cost per month of 30 days?

Teaching procedure: Use Demonstrations No. 2 and No. 3 of the K.C.R.E.A. Demonstration Manual.

Vocational Agriculture II Suggested Lesson Plan

Enterprise: Farm electrification

Job: Determining wire size.

Objectives:

1. Develop interest in using correct wire size for a farm.
2. Understanding of the principles of economical wiring with correct wire size.
3. Understanding effects of inadequate wire size.
4. Ability to select correct size of wire for a given job.

Equipment and material:

1. Demonstration panel.
2. Voltmeter.
3. Different sizes and types of wire.

References:

1. Wiring Simplified, by Richter, p. 24-30.
2. Demonstration Manual, by the K.C.R.E.A., Demonstrations Nos. 8, 9, and 10.

Questions for study:

1. Why is wire size important?
2. What is the purpose of the National Electric Code?

Vocational Agriculture II Suggested Lesson Plan (Con't.)

Questions for study (Con't.)

3. What is load demand and how may it be determined?
4. List the factors to be considered when selecting size of wire for a circuit.
5. Determine the wire size to be used when the 115-volt circuit has a load of 1600 watts, length of run of 100 feet, and the allowable voltage drop is one per cent.
6. Determine wire size for above problem if it is a 230-volt circuit.

Teaching procedure: Use Demonstrations Nos. 8, 9, and 10, of the K.C.R.E.A. Demonstration Manual.

Vocational Agriculture II Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Selecting wiring material.

Objectives:

1. Familiarization with the different types of materials used for conductors and insulators.
2. Ability to select proper type of wiring and receptacles for the job.
3. Ability to identify different wiring materials.
4. Ability to use the National Electric Code.

Equipment and material:

1. Various types of wiring material.
2. Assortment of receptacles and fixtures.

References:

1. Wiring Simplified, by Richter, p. 26-30, 108-117.

Vocational Agriculture II Suggested Lesson Plan (Con't.)

References (Con't.)

2. Farm Mechanics Text and Handbook, by Phipps, McColly, Scranton, and Cook, p. 625-632.
3. National Electric Code.

Questions for study:

1. What materials are most commonly used for making conductors?
2. What materials are most commonly used in insulators?
3. Why is it necessary to insulate wires?
4. What is the common method used for wire size designation?
5. Which is larger, a No. 14 wire or a No. 6 wire?
6. Where is non-metallic sheathed cable used?
7. What is a convenience outlet?
8. Be able to identify the following wiring material and give the use of each: Meter, service entrance switch, switch, outlet box, junction box, receptacle outlets, conduit, armored cable, non-metallic sheathed cable, convenience outlet, and outlet plug.
9. Practice judging the size of wire and check yourself with a wire gauge.
10. According to the National Electric Code, what types of insulation can be used for outdoor wiring?
11. According to the National Electric Code, can a circuit breaker be used as a switch?

Teaching procedure: Identify common wiring materials with a field trip to the local electrical shop.

Vocational Agriculture II Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Location of switches and outlets.

Objectives:

1. Understand National Electric Code's recommendations.
2. Ability to locate switches and outlets for convenience and safety.
3. Understand safety requirements necessary.
4. Ability to determine the number of outlets and proper location for these outlets.

Equipment and material:

1. Mock-up panel or building to be wired.
2. Pencil and ruler.

References:

1. Wiring Simplified, by Richter, Chapters 5, 6, and 7.
2. Farm Mechanics Text and Handbook, by Phipps, McColly, Scranton, and Cook, p. 645-656.
3. National Electric Code.
4. Electricity in the Home and on the Farm, by Wright, p. 143-170.

Questions for study:

1. Where should switches be located in reference to a door?
2. Why should the switch be installed only on the black-wire side of a circuit?
3. Why is it advisable to know the code rules on location of switches and outlets?

Vocational Agriculture II Suggested Lesson Plan (Con't.)

Questions for study (Con't.):

4. What is the recommended height of a convenience outlet in a kitchen?
5. Is it required to have an outlet box wherever a switch is located?
6. What type of switches and outlets can be mounted on the surface, and where are they used?
7. How many light outlets would be required for a farm shop that is 20 by 40 feet?
8. What is the general recommendation for the number of light outlets for a laying house?
9. List the general recommendations for the number of lights, and convenience and special purpose outlets for a milk room.

Teaching procedure: Demonstration with a mock-up board or the actual job.

Vocational Agriculture II Suggested Job Sheet

Enterprise: Farm electrification.

Job: Replace single-pole switch.

Objectives:

1. Ability to select proper type of switch.
2. Ability to replace worn or broken switch.
3. Understand importance of Underwriters' Laboratory label.
4. Develop an understanding of the safety measures necessary.

Vocational Agriculture II Suggested Job Sheet (Con't.)

Equipment and material:

1. Screw driver.
2. Pocket knife.
3. Electricians pliers or thin-nosed pliers.
4. New single-pole switch.
5. Test lamp.

References:

1. Wiring Simplified, by Richter, Chapters 5 and 13.
2. Electricity in the Home and on the Farm, by Wright,
p. 348-358.
3. Maintaining the Farm Wiring and Lighting System,
University of Georgia, p. 27-28.

Operation procedure:

<u>Steps</u>	<u>Key points</u>
1. Removing old switch	
a. Pull main switch, remove fuse or trip circuit breaker.	1. Circuit must be "dead".
b. Remove screws holding switch plate.	
c. Remove switch plate.	1. Check with test lamp to be sure circuit is "dead".
d. Remove screws holding switch in place.	
e. Remove switch from outlet box.	1. Check for slack in wires.

Vocational Agriculture II Suggested Job Sheet (Con't.)

Operation procedure (con't.):

<u>Steps</u>	<u>Key points</u>
f. Loosen screw terminals and unhook wires from switch.	1. Do not remove screws from terminal.
2. Installing new switch	
a. Scrape bare ends of wire.	1. Makes good electrical contact.
b. Loosen screw terminals on new switch.	1. Do not remove screws.
c. Examine switch to see which end goes up.	1. OFF marking shows when toggle is down.
d. Connect wires to terminal posts.	1. Either wire can be connected to either post. 2. Place screw and wire in proper position for tightening.
e. Push switch into outlet box.	1. Bend excess wire like "accordian".
f. Replace screws that hold switch in place.	1. Adjust switch straight up and down.
g. Replace switch plate and screws.	1. Do not overtighten as it may break plastic plate.
h. Re-establish service to circuit.	

Vocational Agriculture II Suggested Job Sheet (Con't.)

Operation procedure (Con't.):

Steps

- i. Test switch to see if it works.
- j. Clean up tools and material.

Questions for study:

1. Why is it necessary to replace switches?
2. What should be considered when buying new switches?
3. Why turn off the electric service when replacing a switch.
4. Does it make any difference which wire is attached to a terminal? Why?

Vocational Agriculture II Proposed Lesson Plan

Enterprise: Farm electrification.

Job: Determining size of pulley to use.

Objectives:

1. Become familiar with types of drives and belts that can be used.
2. Ability to select correct pulley size for given job.

Equipment and materials:

1. V-pulley and belt.
2. Flat pulley and belt.

References: Farm Mechanics Text and Handbook, Phipps, McColly, Scranton and Cook, p. 405-415.

Questions for study:

1. What types of belts are commonly used on the farm?
2. What are the advantages of V-belts?
3. What are the principal problems involved in using belts?

Vocational Agriculture II Proposed Lesson Plan (Con't.)

Questions for study (Con't.):

4. What is the rule to follow in determining the correct size and speed of pulley?
5. Suppose the drive pulley is 3 inches in diameter and runs at 1725 rpm; what will be the speed of a driven pulley which is 6 inches in diameter?
6. What information is required before selecting a belt for farm use?
7. If a motor runs at 1725 rpm, has a 2-inch pulley, and is to drive a machine at 1000 rpm, what diameter pulley should be used on the driven machine?
8. If the above motor is to drive a grindstone at 100 rpm, what sizes could the pulleys be and when could each be used? Illustrate by means of a sketch.

Teaching procedure: Present sample problems and discussion related to individual problems.

Vocational Agriculture II Suggested Job Sheet

Enterprise: Farm electrification.

Job: Making a small motor portable.

Objectives:

1. Ability to use the same electric motor for several jobs.
2. Opportunity to apply previously learned shop skills into practice.
3. Ability to determine correct size pulley to use.

Equipment and materials:

1. A 1/4- to 1/2-horsepower electric motor.

Vocational Agriculture II Suggested Job Sheet (Con't.)

Equipment and materials (con't.):

2. Two 12-inch pieces of 3/4-inch iron pipe.
3. Two pieces of insulated wire.
4. Four 5/16- by 2-inch stove bolts with lock and plain washers.
5. Step pulley.
6. Screw driver.
7. Small wrenches.
8. Countersink.
9. Center punch.
10. A 5/16-inch drill.

References:

1. Shopwork on the Farm, by Jones, p. 459.
2. Electrical Farm Equipment You Can Build, Westinghouse Electric Corporation.

Operation procedure:

<u>Steps</u>	<u>Key points</u>
1. Form the handle	
a. Twist wires together.	1. Six inches is sufficient.
b. Attach wire to end of motor.	1. Attach to four bolts on end bells.
2. Attach pipes to motor base	
a. Measure distance between center of holes in base of motor.	1. Be sure it is the center-to-center measurement.

Vocational Agriculture II Suggested Job Sheet (Con't.)

Operation procedure (Con't.):

<u>Steps</u>	<u>Key points</u>
b. Lay out measurements on pipes and center punch.	1. Equal distance from center of pipe.
c. Drill 5/16-inch hole	1. Clamp pipe securely before drilling.
d. Countersink the holes in the bottom of the pipe.	1. Just deep enough for heads of stove bolts to be recessed.
e. Attach pipes to motor base.	
3. Fasten the step pulley to motor shaft.	

Questions for study:

1. List as many uses as you have on the farm for a portable electric motor.
2. Outline the procedure for drilling holes in pipe.
3. On which side of the equipment will the motor be placed? Why?
4. Why use a step pulley?
5. Can a large electric motor be made portable? If so, in what way?
6. A portable electric motor has 2-, 3 $\frac{1}{2}$ -, and 4-inch diameter step pulleys running at 1750 rpm. Which of the three steps will be used to run a bench grinder equipped with a 4-inch diameter pulley at 2000 rpm?

Vocational Agriculture II Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Familiarization with electric welder.

Objectives:

1. To familiarize students with the different types of arc-welding machines.
2. To understand the general operating principles of the electric arc welder.
3. To provide information for the care and maintenance of welders.

Equipment and material:

1. Drawing of the essential parts of a welder.
2. Arc welder from shop with case removed.

References:

1. Arc Welding Lessons, by Kugler, p. 10-26.
2. Operator's Manual for the Arc Welder.

Questions for study:

1. What is the difference in design between d-c and a-c arc welders?
2. What is meant by "limited-input type a-c transformer arc welders"?
3. Are the primary and secondary windings connected?
4. What is the maximum amperage recommended to use on rural electric service?
5. List the N.E.M.A. specifications to be found on a limited-input welder's nameplate.

Vocational Agriculture II Suggested Lesson Plan (Con't.)

Questions for study (con't.):

6. When using a transformer-type arc welder, should the primary or the secondary cable be lengthened to reach a welding job that cannot be reached by any other means? Why?
7. What are the important service operations to be performed on a transformer-type electric arc welder?
8. Why is a good ground clamp essential?
9. Trace the circuit on the welder provided.
10. What safety precautions should be observed when using the arc welder?

Teaching procedure: Remove panel from welder and trace circuit.

CAUTION: Do not reach inside case of condenser-equipped welder.

Vocational Agriculture II Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Adapting present farm equipment to electric motor operation.

Objectives:

1. To become familiar with different applications of permanent and portable electric motors.
2. To utilize present motors efficiently.
3. Ability to estimate cost of using an electric motor.
4. To understand the advantages of using electric service.

Equipment and material:

1. Portable and stationary fractional-horsepower motors, pulleys, and belts.

Vocational Agriculture II Suggested Lesson Plan (Con't.)

Equipment and material (con't.)

2. Equipment that can be operated with a portable motor.

Reference: Farm Mechanics Text and Handbook, by Phipps, McColly, Scranton, and Cook, Chapter 47.

Questions for study:

1. What are the chief advantages of operating farm equipment with a fractional-horsepower motor?
2. List several applications for a portable motor.
3. For which applications would you recommend a permanent motor installation?
4. Why should a portable motor be used on some equipment?
5. How much would it cost to operate a cement mixer for five hours?
6. List equipment on your farm that could be adapted to electric motor operation.

Teaching procedure: Visit farms that are operating equipment with electric motors and visit local dealers who have this equipment on display.

Vocational Agriculture III Proposed Course of Study

<u>Job activity</u>	<u>Skills to be acquired</u>
1. Planning outdoor lighting.	a. Planning outdoor lighting. b. Proper materials. c. Safety features.
2. Operating principles of a three-wire system.	a. Principles of 3-wire circuit. b. Advantages of 3-wire system. c. Balancing electrical load.
3. Determining number and location of electrical outlets.	a. Electrical symbols. b. Safety factors. c. Location of outlets in farm buildings. d. Planning home lighting outlet locations.
4. Selection of fixtures.	a. Types of fixtures. b. Selection of fixtures. c. Identification of fixtures. d. Prices.
5. Replacing lighting fixtures and outlets.	a. Selection of material. b. Proper installation. c. Safety procedures.

Vocational Agriculture III Proposed Course of Study (Con't.)

<u>Job activity</u>	<u>Skills to be acquired</u>
6. Replacing a 3-way switch.	a. Operation of 3-way switch. b. Locate faulty switch. c. Locate switch-leg. d. Select type of switch. e. Proper wiring methods.
7. Planning an electric pig brooder.	a. Applications of electricity on the farm. b. Planning electric equipment. c. Selecting wiring materials. d. Determine wire size. e. Safety precautions.

Vocational Agriculture III Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Planning outdoor lighting.

Objectives:

1. To develop ability to plan outdoor lighting to meet present and future needs.
2. To develop ability to select proper materials for the job.
3. To appreciate the advantages of outdoor lighting.
4. Familiarization with the farm distribution system.

Equipment and materials:

1. Assortment of outdoor lighting fixtures.
2. Bulletins from manufacturers of lighting equipment.

Vocational Agriculture III Suggested Lesson Plan (Con't.)

References:

1. Wiring Simplified, by Richter, Chapter 15.
2. Electric Lights for the Farmstead, U.S.D.A. Farmers' Bulletin No. 1838.

Questions for study:

1. Why is it important to light the farmyard?
2. Where should outdoor lights be located?
3. Should outdoor lighting be planned for future need? Why?
4. What are some of the common types of fixtures used for farmyard lighting?
5. List some safety reasons for having the farmstead well lighted.

Vocational Agriculture III Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Operating principles of the 3-wire system.

Objectives:

1. To become familiar with the operating principles of a 3-wire, 115/230-volt system.
2. To develop ability to balance the electrical load on a 3-wire system.

Equipment and material: Demonstration board and accessories.

Reference: Demonstration Manual, K.C.R.E.A., Demonstration 7, p. 23.

Questions for study:

1. Is it possible to obtain a 115-volt circuit from a 3-wire circuit? How?

Vocational Agriculture III Suggested Lesson Plan (Con't.)

Questions for study (con't.):

2. What is meant by balancing the electrical load?
3. Explain how the load on a 3-wire circuit can be balanced.
4. What are the advantages of a three-wire system over a two-wire system?
5. Compare the current-carrying capacities of a 115-volt and a 230-volt system when a 1380-watt heating element is connected to either one.

Teaching procedure: Present Demonstration No. 8 from the Demonstration Manual of the K.C.R.E.A.

Vocational Agriculture III Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Determine number and location of electrical outlets.

Objectives:

1. Become familiar with recommended location for outlets in the home and in farm buildings.
2. Ability to decide where outlets should be located.
3. To more fully understand the National Electric Code.
4. To use safety as a primary motivating force for proper location of outlets.
5. Familiarization with electrical symbols.

Equipment and material:

1. Plans of home and farm buildings.
2. List of appliances and equipment used in each building.

Vocational Agriculture III Suggested Lesson Plan (Con't.)

References:

1. Wiring Simplified, by Richter, Chapter 15.
2. Farmstead Wiring, by Westinghouse Electric Corporation.
3. Electric Light for the Farmstead, U.S.D.A. Farmers' Bulletin No. 1838.

Questions for study:

1. What are the main features of a wiring system?
2. List the two main types of wiring systems.
3. Show by drawings the electrical symbol for a wall outlet, junction box, single-pole switch, duplex convenience outlet, and circuit breaker.
4. How many lighting outlets are recommended for a dairy barn whose litter alley is 48 feet long?
5. Where should outlets be located in the poultry laying house?
6. Locate present outlets for your home and farm buildings. Are they adequate?
7. Draw plans for your buildings with outlets located as recommended.

Teaching procedure: Field trip to an adequately and an inadequately wired farmstead.

Vocational Agriculture III Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Selecting electrical fixtures.

Vocational Agriculture III Suggested Lesson Plan (Con't.)

Objectives:

1. Familiarization with the different types of electrical fixtures.
2. To develop ability to select fixtures required for a specific job.
3. Ability to identify different fixtures.
4. To develop ability to estimate cost of fixtures.

Equipment and material:

1. Assortment of electrical fixtures.
2. Current price list of the fixtures.

References:

1. Wiring Simplified, by Richter, p. 108-117.
2. Catalogue, Sears Roebuck and Company.

Questions for study:

1. Why is it important to know the different electrical fixtures and their uses?
2. What types of fixtures would you use if you wanted to put a light in a hay mow? Why?
3. What special consideration is given to fixtures that are placed outside?
4. What is a switch box? List the several different types, and cost of each type.
5. What is the price of a surface-mounted, single-pole switch?
6. Be able to identify the electrical fixtures that are on display.

Vocational Agriculture III Suggested Job Sheet

Enterprise: Farm electrification.

Job: Replacing lighting fixtures and outlets.

Objectives:

1. Ability to select proper outlet for the job.
2. Ability to properly install the outlet box.
3. Develop appreciation for the safety benefits of properly installed lighting.

Equipment and material:

1. Lighting fixture and outlet.
2. Screw driver.
3. Pocket knife.
4. Solderless connectors.

References:

1. Maintaining the Farm Wiring System, University of Georgia.
2. Wiring Simplified, by Richter, Chapter 14.

Operation procedure:

<u>Steps</u>	<u>Key points</u>
1. Remove old fixture	
a. Cut off current.	1. Circuit must be "dead".
b. Remove light globe.	
c. Remove light bulb.	
d. Disconnect fixture from wall or ceiling.	
e. Disconnect feeder wires from fixture terminals.	

Vocational Agriculture III Suggested Job Sheet (Con't.)

<u>Steps</u>	<u>Key points</u>
2. Install new outlet (if needed)	
a. Place selected outlet box in mounting position.	1. Determine which screw holes to use and the knock-out plugs to be removed.
b. Remove necessary knock-outs.	1. One knock-out for cable or each wire.
c. Insert cables in box.	
d. Tighten cable clamps.	1. Be sure clamp grips cable sheath.
e. Fasten box securely in place.	1. Use method that best fits the type of box.
3. Mount new fixture	
a. Prepare ends of wire to be attached to fixture.	1. Follow procedure used before.
b. Attach wires to fixture.	1. Follow directions for the type of fixture.
c. Replace light bulb in socket.	
d. Mount lamp globe in fixture.	
e. Re-establish service to circuit.	

Vocational Agriculture III Suggested Job Sheet (Con't.)

Questions for study:

1. Why should the electric current be disconnected from the circuit?
2. List the procedure for installing the type of outlet that you have chosen for the job.
3. How is the wire prepared for the outlet terminals?
4. Is the black wire connected to the brass terminal? Why?

Vocational Agriculture III Suggested Job Sheet

Enterprise: Farm electrification.

Job: Replacing a 3-way switch.

Objectives:

1. To understand how a three-way switch operates.
2. Ability to locate a faulty three-way switch.
3. Ability to determine switch-leg.
4. Ability to select type of switch required.

Equipment and materials:

1. New three-way switch.
2. Screw driver with insulated handle.
3. Pocket knife.
4. Thin-nosed pliers
5. Test lamp.
6. Pencil.

References:

1. Maintaining the Farm Wiring and Lighting System, University of Alabama.
2. Wiring Simplified, by Richter, p. 41-43.

Vocational Agriculture III Suggested Job Sheet (Con't.)

Operation procedure:

<u>Steps</u>	<u>Key points</u>
1. Locate faulty switch	
a. Determine type of switch.	1. If side or end mounted, remove from box.
b. Work both switches until light works.	
c. Snap each switch to opposite position.	
d. Label the terminal screws.	1. Pencil letters A, B, C on wall next to box.
e. Touch test lamp to terminals A and B, then to terminals A and C, then to terminals B and C.	1. If light burns in one of these combinations, it is faulty and needs replacing. If test lamp does not burn, the switch is good.
2. Remove faulty switch.	
a. Locate switch-leg wire and terminal.	1. Either black or copper-colored on most switches.
b. Disconnect electric service to circuit.	
c. Disconnect switch-leg and bend away.	1. Must be able to identify this wire.

Vocational Agriculture III Suggested Job Sheet (Con't.)

<u>Steps</u>	<u>Key points</u>
d. Disconnect other two wires.	1. Bend to another position.
3. Install new switch.	
a. Examine new switch to find switch-leg terminal.	
b. Attach switch-leg wire to switch-leg terminal.	
c. Attach other two wires to remaining terminals.	
d. Replace switch as previously instructed.	

Questions for study:

1. Where are three-way switches used?
2. Draw a simple wiring diagram of a three-way switch circuit.
3. Why is the electric service left on when checking for the faulty switch?
4. What safety precautions are necessary?
5. Why is the switch-leg wire important?
6. How can you determine the quality of a three-way switch?

Vocational Agriculture III Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Planning an electric pig brooder.

Objectives:

1. To understand applications of electricity on the farm.

Vocational Agriculture III Suggested Lesson Plan (Con't.)

Objectives (Con't.):

2. Ability to plan and construct equipment that uses electricity.
3. Ability to recognize safety precautions in the construction of equipment.

Equipment and materials:

1. Blueprints of pig brooders.
2. Price list of materials to be used.

References:

1. Farm Mechanics Text and Handbook, by Phipps, McColly, Scranton, and Cook, p. 658.
2. Electrical Equipment You Can Build, Westinghouse Electric Corporation.

Questions for study:

1. What per cent of the number of pigs farrowed are raised to weaning time?
2. What can be done to reduce these losses?
3. List several reasons for using a pig brooder.
4. Plan a pig brooder for use on your home farm.
5. What is the most common source of heat for a pig brooder?
6. How long is the lamp-type of brooder left in the farrowing pen?
7. How much would it cost to operate a pig brooder for ten days in February?
8. If one additional pig per litter is saved, would the pig brooder pay for itself?

Vocational Agriculture III Suggested Lesson Plan (Con't.)

Questions for study (con't.):

9. What precautions are necessary in planning and constructing an electric brooder?

Teaching procedure: Field trip to farms that use electric pig brooders.

Vocational Agriculture IV Proposed Course of Study

<u>Job activity</u>	<u>Skills to be acquired</u>
1. Planning farmstead wiring.	a. Load center. b. Future planning. c. National Electric Code. d. Principles of planning.
2. Determining number and type of branch circuits.	a. Types of branch circuits. b. Planning the wiring system. c. Branch circuit protection. d. National Electric Code provisions.
3. Determining correct type of pump for a water system.	a. Type of pump. b. Planning a water system. c. Extending electrical service. d. Daily consumption. e. Economy of using electricity.
4. Servicing electric motors properly.	a. Type bearings. b. When to lubricate. c. Enemies of motors. d. Recommended lubricant.

Vocational Agriculture IV Proposed Course of Study (Con't.)

<u>Job activity</u>	<u>Skills to be acquired</u>
5. Selecting electric motors for the farm.	<ul style="list-style-type: none"> a. Types of motors. b. Sizes of motors. c. Selection. d. Correct wire size.
6. Reverse rotation of an electric motor.	<ul style="list-style-type: none"> a. Parts of motors. b. Types of motors. c. Methods of reversing.
7. Providing electric motor protection.	<ul style="list-style-type: none"> a. Type protective devices. b. Install protective devices.
8. Determining causes of electric motors overheating.	<ul style="list-style-type: none"> a. Types of overheating. b. Locating causes. c. Correcting overheating causes.

Vocational Agriculture IV Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Planning farmstead wiring.

Objectives:

1. Understand the importance of planning for the future.
2. Determining the load center for the farmstead.
3. Develop ability to apply previously learned knowledge of electricity.
4. To become familiar with the principles of planning a wiring system.

Vocational Agriculture IV Suggested Lesson Plan (Con't.)**Equipment and material:**

1. An available farm to obtain problem data.
2. Measuring tape, ruler, pencil, paper, lightweight cardboard 8-1/2 by 11 inches, and graph paper.

References:

1. Demonstration Manual, K.C.R.E.A., Lessons No. 11 and No. 12.
2. Farmstead Wiring, by the Westinghouse Electric Corporation.

Questions for study:

1. What is the first step in making a complete plan for a wiring system for a building or farmstead?
2. Why is it important to make a good electrical system plan before the wiring is started?
3. Why is the electric load center important?
4. How is the electrical load center located?
5. According to the National Electric Code, what types of insulation can be used for outdoor wiring?
6. What clearance is required over driveways?
7. Determine the size wire required for your home farm from the distribution pole to the barn.

Teaching procedure: Present and solve a sample problem in planning farmstead wiring, using either a student's home farm or any other available farm for reference data.

Vocational Agriculture IV Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Determining number and type of branch circuits.

Objectives:

1. Become familiar with the different types of branch circuits.
2. To understand how to determine number of branch circuits.
3. To become familiar with provisions of National Electric Code.

Equipment and materials:

1. Ruler.
2. Drawing paper.

References:

1. Electricity in the Home and on the Farm, by Wright, p. 132, 345-347.
2. National Electric Code.

Questions for study:

1. What is a branch circuit?
2. List the three types of branch circuits and uses of each.
3. Why is it important to make a good wiring plan before the wiring is started?
4. Outline the general procedure used to determine the number of branch circuits.
5. How is the wire size for the branch circuits determined?
6. What type of protection is used on branch circuits?

Teaching procedure: Present a practical problem related to a home farm situation.

Vocational Agriculture IV Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Determining correct type of pump for a water system.

Objectives:

1. Familiarization with the different types of pumps used with a water system.
2. Planning a home water system.
3. Extending electrical wiring to include the water system.

Equipment and material: Assortment of pumps or diagrams of pumps.

References:

1. Running Water in the Home and on the Farm, Sears Roebuck and Company.
2. Farm Mechanics Text and Handbook, Phipps, McColly, Scranton, and Cook, Chapter 40.

Questions for study:

1. What is the difference between a shallow and a deep well?
2. How many gallons of water would a family of four, with 10 milk cows, 200 chickens, and 50 pigs consume daily?
3. What would be the friction loss in a 3/4-inch pipe, carrying 8 gallons per minute over a distance of 200 feet?
4. List three types of pumps and their uses.
5. Should a separate circuit be provided for the water pump?
6. Compare the costs of using electricity to pump water and pumping and carrying water by hand.
7. Outline the procedure required to plan a water system.

Teaching procedure: Field trip to a local dealer to become familiar with the operating principles of the different pumps.

Vocational Agriculture IV Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Servicing electric motors properly.

Objectives:

1. Learn the different types of motor bearings.
2. To know when and how to oil or grease the different types of motor bearings.
3. To know the type of oil or grease recommended for use.

Equipment and material:

1. Electric motors that need servicing.
2. Recommended oil or grease.
3. Different types of bearing.

References:

1. Farm Mechanics Text and Handbook, by Phipps, McColly, Scranton, and Cook, p. 668.
2. Selecting Farm Electric Motors, Controls, and Drives, University of Georgia, p. 11-12.

Questions for study:

1. List the three main types of bearings used in electric motors.
2. How can the different types of bearings be identified?
3. What are some of the enemies of electric motors?
4. Can a sleeve-bearing motor be mounted in all positions? Why?
5. How often should bearings be oiled?
6. Is it possible to over lubricate an electric motor?
7. Should the motor be oiled while running? Why?

Vocational Agriculture IV Suggested Lesson Plan (Con't.)

Questions for study (con't.):

8. What type of lubricant is recommended for the different types of bearings?
9. Make a motor lubrication guide chart for motors on your home farm.

Teaching procedure: Service motors in shop, or motors brought in from boy's home farm.

Vocational Agriculture IV Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Selecting electric motors for the farm.

Objectives:

1. To learn the different types of motors and the use for each.
2. To develop ability to select the correct motor for a given job.
3. To determine wire size required for the use of motors.

Equipment and material:

1. Different types of electric motors.
2. Chart of motor sizes for different jobs.

References:

1. Farm Mechanics Text and Handbook, by Phipps, McColly, Scranton, and Cook, Chapter 47.
2. Wiring Simplified, by Richter, Chapter 16.

Questions for study:

1. What factors should be considered in selecting electric motors?
2. List three advantages of using electric motors.

Vocational Agriculture IV Suggested Lesson Plan (Con't.)

Questions for study (con't.):

3. Is it possible to use a smaller electric motor than a gasoline-driven motor? Why?
4. How can the size of an electric motor for a particular job be determined?
5. What are the principle types of electric motors? Give the main use of each.
6. List some of the special features found on electric motors. Where and when should they be used?
7. Assume a water pump is on a separate branch circuit and the pump is 300 feet from the distribution pole. What size wire would be necessary to operate a one-horsepower motor operating on 115 volts? What is the allowable voltage drop?

Teaching procedure: Relate the selection of motors to the boy's home farm, especially if a problem arises as to type and size of motor to select.

Vocational Agriculture IV Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Reverse rotation of an electric motor.

Objectives:

1. To become familiar with the operating parts of motors.
2. To become familiar with the type of motor that can be reversed.
3. To understand the methods used to reverse motors.

Vocational Agriculture IV Suggested Lesson Plan (Con't.)

Equipment and material:

1. Several different types of electric motors.
2. Wiring diagrams of electric motors.
3. Test lamp and screw driver.

References:

1. Electricity in the Home and on the Farm, by Wright,
p. 176-195.
2. Selecting Farm Electric Motors, Controls, and Drives,
University of Alabama.

Questions for study:

1. List the main types of motors.
2. List the main parts of a motor and their function.
3. What determines the direction of rotation of a motor?
4. Can a capacitor-start motor be reversed? If so, how?
5. How is a repulsion-induction motor reversed?
6. Work out wiring diagrams handed out by the instructor.
7. Why is it important to have a wiring diagram of the electric motor?
8. How is a test lamp used to find the starting winding?

Teaching procedure: Reverse the direction of rotation on several motors in the shop.

Vocational Agriculture IV Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Providing electric motor protection.

Objectives:

1. Familiarization with the types of protection devices.
2. Ability to install motor protection devices.

Equipment and material:

1. Overload protective devices.
2. Burned-out electric motor.

References:

1. Farm Mechanics Text and Handbook, by Phipps, McColly, Scranton, and Cook, p. 665.
2. Electricity in the Home and on the Farm, by Wright, p. 196-203.

Questions for study:

1. What are the two purposes of electrical controls on motors?
2. What are four methods of providing motor overload protection?
3. Why do motors need protection from low voltage? From overloads?
4. Can an ordinary fuse be used for motor protection? Why?
5. Explain how a fusetron fuse operates.

Teaching procedure: Install a motor protection device on a motor in the shop or at boy's home farm.

Vocational Agriculture IV Suggested Lesson Plan

Enterprise: Farm electrification.

Job: Determining causes of electric motors overheating.

Objectives:

1. Become familiar with the possible causes of electric motors overheating.
2. Ability to recognize and correct causes for motor overheating.
3. Develop an interest in the proper operation of electric motors.

Equipment and material:

1. Electric motor.
2. Screw driver and adjustable wrench.

References:

1. A Guide to Care of Electric Motors, by Allis-Chalmers Mfg. Company, p. 12-16.
2. Electricity in the Home and on the Farm, by Wright, p. 203-225.

Questions for study:

1. List four reasons for an electric motor to overheat.
2. How can each be corrected?
3. What causes bearings to overheat?
4. List the correction for each.
5. Should electric motors be given special care? What?
6. What factors could cause the commutator to become hot?
7. How can this be prevented?

Vocational Agriculture IV Suggested Lesson Plan (Con't.)

Questions for study (con't.):

8. What could happen if the motor runs too hot for a length of time?

9. Does improper wire size cause a motor to burn out? Why?

Teaching procedure: Check electric motors that have been running too hot and locate the cause.

References for the Lesson Plans and Job Sheets

A Guide to Care of Electric Motors. Milwaukee: Allis-Chalmers Manufacturing Company, n.d.

Beveridge, Elizabeth and Albert V. Krewatch. Electric Light for the Farmstead. United States Department of Agriculture Farmers' Bulletin 1838. Washington: Government Printing Office, 1951.

Electrical Equipment You Can Build. Pittsburgh: Westinghouse Electric Corporation, n.d.

Farmstead Wiring. Pittsburgh: Westinghouse Electric Corporation. 1947.

Jones, Mack M. Shopwork on the Farm. New York: McGraw-Hill. 1955.

Kugler, Harold L. Arc Welding Lessons for School and Farm Shop. Cleveland: The James F. Lincoln Welding Foundation. 1950.

Lipper, Ralph I. and Kenneth A. Harkness. Demonstration Manual for Teaching the Fundamentals of Farm Wiring. Kansas State College: Kansas Committee on the Relation of Electricity to Agriculture in Cooperation with Department of Agricultural Engineering Department, n.d.

Maintaining the Farm Wiring and Lighting System. University of Georgia: Agricultural Engineering Department. 1952.

National Electric Code. New York: National Board of Fire Underwriters. 1953.

Richter, H. P. Wiring Simplified. Twenty-second edition. Minneapolis: Park Publishing Co. 1951.

Running Water in the Home and on the Farm. Kansas City, Mo.:
Sears Roebuck and Co. 1953.

Selecting Farm Electric Motors, Controls and Drives. University
of Georgia: Agricultural Engineering Department. 1953.

Phipps, Lloyd J., H. F. McColly, L. L. Scranton, and G. C. Cook.
Farm Mechanics Text and Handbook. Danville, Ill.: The
Interstate. 1954.

Wright, Forrest B. Electricity in the Home and on the Farm.
Third edition. New York: Wiley and Sons. 1950.

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LITERATURE CITED

- Bortfield, C. J., and Joe F. Davis. Electricity on Farms in Southwestern Kansas. Kansas Agriculture Experiment Stations Bulletin 351. December, 1951.
- Eaton, Edward D. "Insurance for Electric Power." Agriculture Education Magazine, February, 1952, 24:188.
- Harris, Roland. "Farm Mechanics Today." Agriculture Education Magazine, June, 1955, 27:267.
- Jacobs, C. O. "Evaluation of Job Activities in Farm Mechanics." Agriculture Education Magazine, February, 1954, 27:177.
- Johnson, Overton R. "Integrating Electricity with Vocational Agriculture." Industrial Arts and Vocational Education, September, 1955, 44:205-206.
- Kansas Inter-Industry Farm Electric Utilization Council. A Survey of Farm and Home Electric Equipment Used by Kansas Rural Residential and Farm Consumers and the Immediate Potential. Topeka: The Council. 1955.
- Lipper, Ralph I. and Kenneth A. Harkness. Demonstration Manual for Teaching the Fundamentals of Farm Wiring. Kansas State College: Kansas Committee on the Relation of Electricity to Agriculture in Cooperation with Department of Agricultural Engineering, n.d.
- London, H. H. "Education--The Key to Improved Use of Electricity on the Farm." Agriculture Education Magazine, April, 1949, 21:196.
- Oliver, E. F. "The Farm Wiring Menace." Agriculture Education Magazine, January, 1955, 27:159.
- Morford, V. J. Methods of Teaching Farm Mechanics. Minneapolis: Burgess. 1956.
- Perry, Don E. "Organizing an Industrial Arts Course in Electricity." Industrial Arts and Vocational Education, March, 1955, 44:110-114.
- Phipps, Lloyd J. and Glen C. Cook. Handbook on Teaching Vocational Agriculture. Danville, Illinois: The Interstate. 1952.
- Phipps, Lloyd J., H. F. McColly, L. L. Scranton, and G. C. Cook. Farm Mechanics Text and Handbook. Danville, Illinois: The Interstate. 1954.

Price, H. L. "Planning Instruction in Rural Electrification." Agriculture Education Magazine, June, 1940, 12:235.

Snowden, Obed L., G. C. Cook, and Clyde Walker. Practical Methods in Teaching Farm Mechanics. Danville, Illinois: The Interstate. 1952.

The Thirty-first Annual Report of the Kansas Committee on the Relation of Electricity to Agriculture. Kansas State College: Department of Agricultural Engineering. 1955.

Wakeman, T. J. "Teach Farm Electricity by Example and Demonstration." Better Farming Methods, May, 1951, 23:72-74.

Walker, Clyde. "Rural Electrification in Vocational Agriculture." Agriculture Education Magazine, July, 1941, 12:206.

APPENDIX

Rural Electrification Questionnaire

AGRICULTURAL ENGINEERING DEPARTMENT
Kansas State College

Rural Electrification Questionnaire

Your name _____ Town _____ County _____
 Year graduated from High School _____.
 Number years vocational agriculture work completed _____.
 Are you presently farming? Yes ___ No ___.

Based upon your experiences, place a check (✓) in the one column which most nearly describes your ability in regard to the following jobs.

JOB	Perform when neces- sary	If trained would do	Prefer to hire done	Have no need for
1. Figure cost of electricity used per month by reading meter.				
2. Replace blown fuses with proper size fuse and/or reset circuit breaker				
3. Determine reason for fuse blowing or multi-breaker tripping.				
4. Compute operating cost of electrical equipment.				
5. Determine voltage drop and its effect on lights and equipment.				
6. Replace outlets, switches or light fixtures.				
7. Install new wiring, switches and convenience outlets.				
8. Repair extension cords.				
9. Splice electric wire.				
10. Install three and four-way switches.				
11. Follow wiring diagrams used for motors and circuits.				
12. Locate wiring troubles.				
13. Plan new wiring to meet the future needs.				
14. Determine kind and number of switches and outlets for each building.				
15. Determine kind and number of switches and outlets for each building.				
16. Determine number of branch circuits.				
17. Balance the load on a 3-wire 115-230 volt system.				
18. Check and evaluate existing wiring circuits.				
19. Determine wire sizes to be used for a given load.				
20. Select proper wiring materials for the job.				
21. Locate switches and outlets for convenience and safety.				

JOB	Perform when necessary	If trained would do	Prefer to hire done	Have no need for
22. Use remote control switches where possible.				
23. Locate lighting fixtures to best advantage.				
24. Select fixtures suitable and safe for the job.				
25. Determine correct size and type of motor for a given job.				
26. Provide proper motor protection by the use of fuses and circuit breaker.				
27. Clean and lubricate electric motors properly.				
28. Locate causes for motor overheating.				
29. Reverse electric motors.				
30. Correct motor troubles as bearings, overheating and failure to start.				
31. Adapt present farm equipment to electric motor operation.				
32. Make electric motors portable.				
33. Select proper size pulleys for speed desired.				
34. Plan and build electric brooding equipment for chickens, pigs or lambs.				
35. Construct hay and grain drying equipment.				
36. Install and use water warming devices for livestock and poultry.				
37. Use operators manual to install and maintain equipment purchased.				
38. Connect and use timing devices for turning on lights and motors.				
39. Plan a water system for a farm.				
40. Select correct type of water pump to meet your needs.				
41. Select correct size pump and motor for a water system.				
42. Protect pump and pipes from freezing during winter.				
43. Use electric grain elevators, grinders and/or mixers.				
44. Provide adequate cooling for milk and eggs by refrigeration.				
45. Install outdoor lighting when required.				
46. Rearrange indoor lighting to meet present and future needs.				
47. Use equipment ground on electric drills and other electric equipment.				
48. Use electric welder for repair jobs.				

Power Suppliers in Kansas Who Have
Demonstration Boards and Lighting
Kits Available for Loan.¹

Company	Demonstration boards	Lighting Kits
Kansas Gas and Electric Company		
Pittsburg	1	1
Independence	1	1
Fort Scott	1	1
Arkansas City	1	1
Newton	1	1
El Dorado	1	1
Yates Center	1	1
Wichita	1	3
Kansas Power and Light Company		
One demonstration board of their own design (arranged for through Earl Palmberg, Topeka)		
Topeka		1
Leavenworth		1
Lawrence		1
Emporia		1
Parsons		1
Manhattan		1
Hiawatha		1
Abilene		1
Salina		1
Hutchinson		1
Western Light and Telephone Company		
Concordia		1
Harper		1
Dodge City		1
Great Bend		2
Empire District Electric Company		
Joplin, Missouri	1	1

¹ Ralph I. Lipper, Professor, Department of Agricultural Engineering, Kansas State College, has one demonstration board available for loan. Professor Lipper will also attempt to have demonstration boards available for vocational agricultural teachers who do not have access to one. The Demonstration Manuals are available upon request to the Department of Agricultural Engineering.

Company	Demonstration boards	Lighting kits
Kansas City Power and Light Company Overland Park	1	1
Flint Hills Electric Co-op. Council Grove	1	3
Wheatland Electric Co-op. Scott City		1
Coffey County Rural Electric Co-op. Burlington	1	1
C.M.S. Electric Co-op. Meade		2
Jewell Mitchell Co-op Electric Co. Mankato	2	1
Victory Electric Co-op. Dodge City		1
Ninnescah Rural Elec. Co-op. Pratt	2	1
Radiant Electric Co-op. Fredonia		1
P.R. & W. Electric Co-op. Wamego	1	1
Pioneer Electric Co-op. Ulysses		1
N.C.K. Electric Co-op. Belleville		
Doniphan Electric Co-op. Troy		1
C & W Electric Co-op. Clay Center	2	2
Ark Valley Electric Co-op. Hutchinson	1	3
Leavenworth-Jefferson Electric Co-op. McClouth	1	2

Company	Demonstration boards	Lighting kits
Norton-Decatur Electric Co-op. Norton	2	
Northwest Kansas Electric Co-op. Bird City	1	
Western Co-op Electric Wakeeney	2	
Lane-Scott Electric Co-op. Dighton	1	

THE DEVELOPMENT OF COURSE CONTENT
IN FARM ELECTRIFICATION TO BE USED BY
VOCATIONAL AGRICULTURE TEACHERS OF KANSAS

by

KENNETH FRANKLIN KERN

B. S., Kansas State College
of Agriculture and Applied Science, 1953

AN ABSTRACT OF
A THESIS

submitted in partial fulfillment of the
requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Engineering

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1956

The application of electrical power has become increasingly important in Kansas, as indicated by the fact that over 92 per cent of the farms were utilizing electrical service in 1954. To insure maximum benefits from a farm electrical system, a basic knowledge of electricity and the equipment it can operate is necessary. The purpose of this study was to develop a proposed course of study, lesson plans, and job sheets in farm electrification to be used as a guide by vocational agriculture teachers in Kansas.

The form questionnaire was used to determine if farmers felt a need existed for instruction in farm electrification. A list of vocational agriculture teachers in Kansas was obtained from the Vocational Education office at Kansas State College. Two questionnaires were mailed to one hundred fifty of the teachers. Each teacher was requested to distribute the questionnaires to two young farmers in his community who had received vocational agriculture instruction in high school. Of the three hundred questionnaires distributed, one hundred four were returned.

The results of the survey indicated that the farmers had a total need for instruction in the following phases of electricity: (1) Fundamentals of electricity, (2) electrical safety, (3) electrical skills, (4) planning the electrical system, (5) electrical farm equipment, (6) electric motors, and (7) farm conveniences.

Based upon the results of the questionnaire and the survey of related literature, a proposed course of study in farm

electrification was developed and distributed over four years of instruction in vocational agriculture. To complement the proposed course of study, suggested instructional lesson plans and operational job sheets were developed for the job activities listed in the proposed course of study. The suggested lesson plans and job sheets were developed for the following job activities for the year indicated:

Vocational Agriculture I

1. Figure cost of electricity used per month.
2. Repair and make extension cord.
3. Splice electric wire.
4. Study of fuses and circuit breakers.
5. Study of voltage drop and its effect.

Vocational Agriculture II

1. Compute operating cost of electrical equipment.
2. Determine wire size.
3. Select wiring material.
4. Location of switches and outlets.
5. Replacing a single-pole switch.
6. Making a small motor portable.
7. Familiarization with electric welders.
8. Adapting present farm equipment to electric motor operation.
9. Determining size of pulleys to use.

Vocational Agriculture III

1. Planning outdoor lighting.
2. Operating principles of a three-wire system.
3. Determining number and location of electrical outlets.
4. Selection of fixtures.
5. Replacing lighting fixtures and outlets.
6. Replacing a three-way switch.
7. Planning an electric pig brooder.

Vocational Agriculture IV

1. Planning farmstead wiring.
2. Determining number and type of branch circuits.
3. Determining correct type of pump for a water system.
4. Servicing electric motors properly.
5. Selecting electric motors for the farm.
6. Reversing rotation of an electric motor.
7. Providing electric motor protection.
8. Determining causes of electric motors overheating.