TABLE 34.—Years of service of the two groups of vocational agriculture teachers as randomly divided

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APPENDIX F

VOCATIONAL AGRICULTURE TEACHERS -- YEARS OF SERVICE
110 Plug holes in metal with an arc welder.
111 Cut cast iron with an oxy-acetylene torch.
112 Bend or shape sheet metal with pliers, seamers or with a vise and hammer.
113 Correct an air or water logged water supply tank.
114 Remove obstructions from traps and drain lines.
115 Plan a high school agricultural mechanics shop.
116 Plan for disposal of scrap and waste materials.
117 Select and use levels.
118 Select and use a planer.
119 Select and use glue and other adhesives to join wood.
120 Apply plywood or other building boards.
Develop an inventory procedure for control of tools, equipment, supplies and materials.

Make a free-hand sketch utilizing the three principal views.

Select and use precision measuring tools such as micrometers.

Select and use a portable electric drill.

Clean and preserve tools.

Select the best method of fastening or joining wooden members.

Lay out and cut rafters.

Select and use bolt cutters.

Select and use thread chasers.

Select and use and electric soldering gun.

Solder copper.

Weld horizontally with metal in a vertical plane.

Oxy-acetylene fusion weld with filler rod.

Select and use plumbing tools.

Install soft copper pipe.

Install flexible plastic pipe.

Select and apply wood preservatives.

Identify procedures that might insure safety in the handling of materials.

Select and use layout tools for wood.

Place and finish concrete.

Select lumber by classification and grade.

Select and use common wood and lag screws to fasten wood.

Layout a foundation.

Bend, twist or shape cold metal.

Describe metal temperatures and characteristics by heat colors.
061 Make multiple pass welds.
062 Cut or pierce steel with a cutting torch.
063 Identify safety practices in the handling of welding gas cylinders.
064 Obtain project plans and select projects for students.
065 Select and use a portable circular saw.
066 Specify and order standard steel shapes by name and dimension.
067 Select solder and flux for a given application.
068 Weld steel castings.
069 Bronze weld cast iron.
070 List the safety precautions in the use of hand tools.
071 Describe how to prevent and how to extinguish fires.
072 Plan storage of tools, equipment, supplies and materials.
073 Select and utilize agricultural mechanics training aids and audio-visual materials.
074 Order materials using common units and designations.
075 Select and use bits and hand drills.
076 Replace handles in tools.
077 Select and use various kinds of nails.
078 Select and apply roofing materials.
079 Select and use metal files.
080 Explain the meaning of arc welder name plate information.
081 Weld vertically with the metal in a vertical plane.
082 Explain the principles of fusion and adhesion welding.
083 Oxy-acetylene fusion weld without filler rod.
084 Maintain and repair valves and faucets.
Discuss the safe transportation of tractors and equipment on the highway by driving and by trucking.

Determine whether a charging system fault lies with the generator (alternator) or the regulator.

Define indicated, friction, flywheel, brake, belt, drawbar, PTO and rated horsepower.

Identify engine types by classification of fuel used, valve arrangement, cylinder arrangement, method of cooling and displacement.

Use and interpret the readings of a radiator and radiator cap tester.

Remove and replace a distributor.

Obtain and interpret Nebraska Tractor Test Summaries.

List safety practices to be observed in the use of power tools in the shop.

Sharpen twist drills.

Control welding distortion, warping and cracking.

Describe the safe dress for shop work.

Identify first-aid procedures to use in case of an accident.

Calculate board feet.

Select the correct welding electrode for a given application.

Identify weld quality in terms of the four welding fundamentals.

Weld cast iron.

Select, use, clean and store paint brushes.

Maintain school shop discipline.

Select and use a radial arm saw.

Select and use a bench or pedestal grinder.

Dress and true a grinding wheel.

Select arc welding equipment, tools and supplies.
020 Change diesel fuel filters.
021 Determine an optimum implement width and tractor size and type given factors of acreage, crops, tillage practices, timeliness, etc.
022 Explain the importance and function of the various types of engine air cleaners.
023 List and explain the functions of the various engine lubricating system components.
024 List and describe the functions of the various engine liquid cooling system components.
025 Set engine high idle rpm by adjusting the governor and/or the governor linkage on a specified engine.
026 Select a battery by type and capacity rating for a given application.
027 Adjust tractor engine clutch free travel.
028 List and explain the basic principles of hydraulics.
029 Describe the operation and purpose of a supercharger and a turbocharger.
030 Service a liquid cooling system in preparation for cold weather operation.
031 Describe the effects of low temperature on battery capacity and engine cranking power requirements.
032 Define and explain how to minimize side draft.
033 Discuss the safe operation of agricultural and industrial tractors and equipment.
034 Change the oil and oil filter of an engine.
035 Remove and install a storage battery.
036 Explain the effect of engine speed and load on optimum spark timing requirements.
037 Define the center of pull and the center of draft.
038 List the various types and explain the operation of hydraulic pumps, valves, cylinders, motors, etc.
Selected Agricultural Mechanics Competencies (E list)

001 Remove and replace points and condenser.

002 List and explain the four strokes of a four-stroke cycle engine.

003 List the possible causes of excess engine oil consumption and explain how to determine each.

004 List and describe the functions of the various components of the gasoline fuel system.

005 List and explain the functions of the various ignition system components.

006 Determine the cause and correct the failure of an engine to crank and/or start.

007 List and explain the two strokes of a two-stroke cycle engine.

008 Identify engine parts by name and function.

009 List the precautions in operating a tractor equipped with a turbocharger.

010 Set valve clearance.

011 List and explain the meaning of A.P.I. oil service classifications.

012 Calculate transmission input to output shaft ratios given the necessary factors.

013 Calculate displacement and compression ratio given the necessary factors.

014 Explain the importance of keeping diesel fuel clean.

015 List and describe the functions of various starting system components.

016 Use and interpret the readings of a coil and condenser tester.

017 Determine tractor operating costs of depreciation, interest, taxes, housing, insurance, fuel, lubricants, maintenance and repair.

018 Explain the meaning of a multi-viscosity oil.

019 List the major causes of engine overheating and explain how each might be corrected.
114 Select the kind and size of pipe to use for a given application.
115 Identify causes of paint failure.
116 Develop a list of desirable tools for various type shops.
117 Select and use hammers and sledges.
118 Select and use a high pressure washer.
119 Construct forms for concrete.
120 Construct wall framing.
089  Sharpen and reshape punches and chisels.
090  Estimate the number and type of concrete blocks needed.
091  Identify building construction members by name.
092  Select and install hinges, pulls and other miscellaneous building hardware.
093  Select and use punches and cold chisels.
094  Remove frozen nuts and bolts that have broken off.
095  Solder galvanized metal.
096  Select, install and maintain an arc welder.
097  Hard surface materials using an arc welder.
098  Select and use self-tapping screws to join sheet metal.
099  Identify and select pipe fittings.
100  Install rigid plastic pipe.
101  Select the type of paint for a given application.
102  Select and apply paint to metal surfaces.
103  Select and use vises and clamps.
104  Estimate the quantity of concrete and materials needed.
105  Cure concrete
106  Describe the characteristics and grades of plywood.
107  Select and use bolts to fasten wood.
108  Build roof trusses.
109  Select and use standard threaded fasteners.
110  Explain how an arc welder operates.
111  Weld sheet metal with an arc welder.
112  Cut sheet metal by hand with tin snips, bench shears or chisels.
113  Use rivets and riveting tools to join sheet metal.
Select and use squares.
Identify metals by a spark or other type test.
Select and use twist drills.
Solder using a propane torch.
Select a proper welding tip size and operating pressures for a given application.
Prepare paint for use by mixing, thinning and straining.
List the safety rules and practices that might prevent falls.
Select and use a power hack saw.
Select, specify and order tools, equipment, supplies and materials.
Read and interpret a drawing or plan.
Identify common hand tools by name.
Select and use a table saw.
Reinforce concrete.
Square a board.
Select and use hand hack saws.
Select and use taps and dies.
Strike and run beads with a D.C. welder.
Cut and pierce metal with an arc welder.
Select oxy-acetylene welding equipment and supplies.
Apply hard surfacing material using an oxy-acetylene torch.
List methods to prevent the build-up of carbon monoxide and other fumes.
Plan and develop a project work procedure.
Select materials for project construction.
Select and use a portable sabre saw.
041 Perform general maintenance on a hydraulic system.
042 Define and explain the importance of an engine's lugging ability.
043 Determine rod and main crankshaft bearing wear.
044 Remove and replace a carburetor and/or a fuel pump.
045 Explain the purpose and principle of operation of a swinging drawbar.
046 Describe the shop requirements for safe eye protection.
047 Describe the safe behavior of shop workers.
048 Strike and run beads with an A.C. welder.
049 Select use and clean a paint spray gun.
050 Describe safety procedures to be used with electrical tools, equipment and devices.
051 Estimate project costs.
052 Identify electrodes by a color code and/or an A.W.S. classification number.
053 Select initial welder heat settings.
054 Make butt, lap and tee welds.
055 Install regulators, hoses and tip. Open tanks, set pressures and check for leaks. Light, adjust and turn off flame.
056 List safety practices to be used when welding.
057 Make a cutting list and a bill of materials.
058 Select and use a bench or floor drill press.
059 Select a grinding wheel for tool sharpening.
060 Reshape a screwdriver blade.
061 List the four fundamentals of welding that control heat.
062 Bronze weld steel.
063 Prepare surfaces to be painted.
064 Control the use and security of tools, equipment and supplies.
020 Describe the general operation and function of a gasoline-fueled engine governing system.

021 List and explain the functions of the various charging system components.

022 Define energy, inertia, force, torque, work, power and horsepower.

023 Service air cleaners and air intake systems.

024 Describe the meaning of oil viscosity index.

025 Describe the effects of engine operating temperature on wear rate, power output, and fuel consumption.

026 Test the specific gravity of a storage battery electrolyte with a hydrometer.

027 List the precautions when jumping or charging batteries.

028 List the various methods of extending tractor tire life.

029 List factors to be considered in the selection of tractor options such as engine, transmission, PTO, hitch, hydraulics, cab, etc.

030 List the effects of adding a turbocharger to an engine not originally equipped with a turbocharger.

031 Explain the air/fuel ratio requirements of an engine for starting, idling, part-load and full-load operation.

032 Explain the meaning of tire dimensions.

033 Explain the operation of basic hydraulic circuits.

034 Remove and replace a cylinder head and gasket.

035 Remove and replace a diesel fuel injection nozzle.

036 Clean, visually inspect and add water to a storage battery.

037 Describe how a change in hitch position affects weight transfer and tractor stability.

038 Compare the advantages and disadvantages of two-wheel drive, four-wheel drive and crawler type tractors.

039 Discuss the safe handling and storage of fuels and lubricants.

040 Test a storage battery with a voltmeter at a high discharge rate.
Selected Agricultural Mechanics Competencies (0 list)

001 Explain the operation of the float, choke, idling and load system of a tractor carburetor.

002 Time the distributor with a timing light.

003 Determine tractor horsepower using a portable PTO dynamometer.

004 Remove and replace a governor.

005 Adjust the idle mixture, load mixture and idle speed screws on a tractor carburetor.

006 Remove, clean, inspect, gap and replace spark plugs.

007 Determine the cause and correct the failure of an engine to run properly or develop horsepower.

008 Compare the two-stroke cycle engine with the four-stroke cycle engine in terms of power, weight, efficiency and application.

009 Use and interpret the readings of a compression gauge.

010 Explain the importance of correct valve clearance.

011 List the functions of oil in a tractor engine.

012 Select an appropriate oil to be used in a tractor engine given the operating and weather conditions.

013 Define bore, stroke, displacement and compression ratio.

014 List and describe the functions of the various diesel fuel system components.

015 Bleed the air from a diesel fuel system.

016 Use a dwellmeter to set point gap.

017 Explain traction changes as affected by dual wheels, inflation, weight on the rear wheels, tire size, tire tread, traction conditions, etc.

018 List and explain the functions of the intake and exhaust system components.

019 Describe the operation and maintenance of the crankcase ventilation system.
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ANSWER SHEETS

Please return only these answer sheets in the self-addressed, stamped envelope enclosed. Try to complete your answers and return them to me by June 15, 1974.

Your response will be confidential and used only as a part of the overall tabulation. It is necessary that I identify these answer sheets so that I may follow-up any nonrespondents.

GENERAL INFORMATION

Id. ____

____ years of teaching vocational agriculture to the nearest year.

Please indicate in the boxes below the agricultural engineering courses you completed in your undergraduate work.

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
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<tbody>
<tr>
<td></td>
<td>Buildings and Equipment for Farmstead Operations</td>
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<td>Agricultural Materials Handling Systems</td>
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<td>(Required for agricultural education majors.)</td>
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<td>231</td>
<td>Electric Power for Agricultural Operations</td>
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<td>240</td>
<td>Teaching of Agricultural Construction and Maintenance</td>
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<td>250</td>
<td>(Required for agricultural education majors.)</td>
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<td>270</td>
<td>Machines for Agricultural Operations</td>
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<td>305</td>
<td>Engineering Methods in Soil and Water Conservation</td>
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<td>550</td>
<td>Rural Housing Technology</td>
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<td>593</td>
<td>Pollution Control and Waste Utilization</td>
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<td></td>
<td>Individual Studies</td>
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<td>Other</td>
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Your reactions to the competencies should be based on the subject matter rather than on behavioral objective words such as: explain, list, identify, describe, discuss, etc.
INSTRUCTIONS

Please fill out the background information as requested on the first sheet of the set of answer sheets.

The remainder of the questionnaire consists of a selected list of agricultural mechanics competencies that a panel of experts agreed should be taught in the agricultural engineering courses required of prospective vocational agriculture teachers at The Ohio State University. Please react to each competency by choosing the best alternative to each of three questions and indicating your selection on the answer sheet.

Question 1. How do you rank your ability to teach or perform this agricultural mechanics competency?
   _____ With little additional study and/or assistance.
   _____ With some additional study and/or assistance.
   _____ With much additional study and/or assistance.

Question 2. Where did you primarily acquire the information required to teach or perform this particular competency?
   _____ Work experience, during high school or later.
   _____ During high school educational experiences.
   _____ During college educational experiences.
   _____ On-the-job teaching vocational agriculture.

Question 3. Do you teach this competency to your high school vocational agriculture classes?
   _____ Yes.
   _____ No

EXAMPLE: Suppose this was a competency that you were to react to.
   096 Calibrate a corn planter.

Let's assume that you teach it, but need to do some additional study before going to class. You primarily learned how to calibrate a corn planter in one of your high school classes. Your answers on the answer sheet should look like this.

<table>
<thead>
<tr>
<th>STUDY &amp;</th>
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NOTE: A few competencies refer to agricultural mechanics abilities that a teacher might well possess and use, but would not likely teach to his classes. For competencies such as 064 and 116 answer question 3 yes if you possess and use the competency even though you don't teach it.
APPENDIX E

VOCATIONAL AGRICULTURE TEACHERS -- INSTRUMENT
FOLLOW-UP LETTER TO NONRESPONDENTS

July 17, 1974

To: Teachers of Vocational Agriculture Completing Two, Three, or Four Years of Service

From: Miles H. Lovingood, Graduate Student, Agr'l. Education

I'm sorry to bother you again, but to have meaningful results from the agricultural mechanics study it is necessary that as many teachers participate as possible.

I missed contacting you at the O.V.A.T.A. annual conference in Columbus last week, but I was able to talk to your supervisor to confirm your employment and address. Both he and I agree that reactions to the agricultural mechanics questionnaire based on your particular experiences and opinions would be a valuable addition to the study.

If I haven't heard from you in a few days I'll send you another copy of the questionnaire. Won't you please react to it and return it to me as soon as possible?

Your response will be appreciated.

Sincerely,

Miles H. Lovingood
FOLLOW-UP LETTER TO NONRESPONDENTS

June 18, 1974

To: Teachers of Vocational Agriculture Completing Two, Three, or Four Years of Service

From: Miles H. Lovingood, Graduate Student, Agricultural Education

I was hoping to have all the returns to the agricultural mechanics questionnaire I sent you by June 15th, but since it is necessary that I have a high rate of return to validate the study I hope that you will still be willing to take the time to complete the questionnaire and return it to me.

If you haven't taken Agricultural Engineering 230 and 240 at The Ohio State University I need to know that also. Just indicate that on the front of the answer sheets and return them to me in the self-addressed, stamped envelope provided.

In case you discarded or are having difficulty finding the questionnaire please let me know so that I may send you another.

Your education and experiences are unique. Won't you please share them for the benefit of others by completing the questionnaire and returning it to me?

I would appreciate your help.
Memo to: Teachers of Vocational Agriculture Completing Their Second, Third, and Fourth Years of Service

From: Carlton E. Johnson, Professor, Department of Agricultural Engineering

We need your assistance in helping us evaluate and revise our two agricultural engineering courses required in the Agricultural Education curriculum. This questionnaire has been sent exclusively to second, third, and fourth year teachers. You have been divided into the groups so that you will respond to only half of all the items highly rated by the panel of experts.

You were chosen to participate in this study because you have had several years of experience, yet we believe you can more easily recall your college educational experiences than teachers who graduated earlier.

By now you should have received the questionnaire concerning some agricultural mechanics competencies. These competencies were highly rated by a panel of experts as being desirable for teachers of vocational agriculture to have acquired as a result of completing Agricultural Engineering 230 (Power for Agricultural Operations) and 240 (Teaching Agricultural Construction and Maintenance) at The Ohio State University.

I hope you will take the time to complete this questionnaire and return it to Miles Lovingood, the graduate student conducting the study. Since less than 100 teachers are being sent the questionnaire, it is vital that each teacher respond. With relatively few teachers included in the study, each response is important and will be heavily weighted.

Please complete the questionnaire and return it at your earliest convenience. Your contribution to the study will be invaluable and will contribute toward a better understanding of teacher needs and curriculum improvements.

Thanks for your help.
To: Teachers of Vocational Agriculture Completing Two, Three, or Four Years of Service

From: Miles H. Lovingood, Graduate Student, Agricultural Education

I realized after I sent you the questionnaire that I hadn't fully explained the scope of the agricultural mechanics study that I am undertaking. I thought this letter could serve that purpose as well as a reminder in case the questionnaire is under some of the paperwork on your desk.

When I was an undergraduate at The Ohio State University I took what was then the equivalent of Agricultural Engineering 230 and 240. Last autumn quarter I took 230 and 240 again, but as individual studies. As these courses were quite similar to those I had taken some 20 years ago, I wondered if these required courses for prospective teachers of vocational agriculture were meeting the needs of teachers in the area of agricultural mechanics. As a result I am conducting this study.

I first made up a list of agricultural mechanics competencies from the notes I had taken in 230 and 240 and from several texts in each area. Dr. Johnson and Professor Huber reviewed the list and a revised and condensed list of 480 competencies was developed.

This list was sent to 14 vocational agriculture teachers (one in each district) with over five years experience who had been identified by their area supervisors as being an above average teacher and competent in the area of agricultural mechanics. In addition to the teachers, Dr. Johnson, Dr. Wilson, Professor Huber and Dick Hummel participated in this part of the study. The "panel of experts" were asked to react to each competency as to whether they agreed that it should be taught in Agricultural Engineering 230 or 240.

From their responses I ranked the competencies from most to least agreed upon. I selected the 240 competencies most agreed upon and sent half of them to each of two groups of second, third and fourth year teachers chosen at random.

There are only 40 teachers in each group. This means that it is essential that there be a high response to the questionnaire in order that the study be valid. If you have not already sent in your response won't you plan to do so before July 15? Only you have the experience to assist in the evaluation of these competencies and their relationship to the course content of Agricultural Engineering 230 and 240.
June 4, 1974

To: Teachers of Vocational Agriculture Completing Two, Three or Four Years of Service

From: Miles H. Lovingood, Graduate Student, Agricultural Education

Remember when you took Agricultural Engineering 230, Power for Agricultural Operations, and Agricultural Engineering 240, Teaching Agricultural Construction and Maintenance? I hope you do, for it is my assumption that teachers completing their 2nd, 3rd and 4th years of service are in a unique position to have had sufficient teaching experience in agricultural mechanics and still be able to recall their formal education in this area.

I am doing a Ph.D. study under the direction of Dr. Bender and Dr. Johnson concerning the agricultural engineering courses that are required of prospective teachers of vocational agriculture while attending The Ohio State University. The results of the study will be used to confirm satisfactory agricultural mechanics competencies taught at the University or to recommend changes.

I am enclosing a questionnaire about some selected agricultural mechanics competencies that a panel of experts considered to be of importance in teaching agricultural mechanics. I hope that you will be willing to take the time to go over the list and indicate how well prepared you are to teach each competency, where you acquired the information and whether or not you teach it.

I know that you are particularly busy at this time of year, but your participation in this study is important as there are relatively few teachers completing their 2nd, 3rd or 4th years of service when compared to all of the vocational agriculture teachers in Ohio. Could you complete the questionnaire and return the answer sheets to me by June 15th?

I'm sure you will be interested to see which agricultural mechanics competencies the panel of experts agreed should be taught prospective teachers of vocational agriculture in college classes.

Your participation in this study is strongly encouraged. As one of relatively few teachers being asked to participate, your response will be of considerable influence and importance. Please take this opportunity to assist in the development of recommendations that might result in the improvement of college instruction in agricultural mechanics for prospective teachers of vocational agriculture.
APPENDIX D

VOCATIONAL AGRICULTURE TEACHERS -- CORRESPONDENCE
| 294 | Select and use axes and hatchets. | 2.39 |
| 295 | Select and use a metal shaper. | 2.28 |
| 296 | Use a forge fire to heat metal. | 2.28 |
| 297 | Construct and maintain a cistern. | 2.22 |
| 298 | Prepare and apply whitewash. | 2.22 |
| 299 | Select and use a milling machine. | 2.17 |
| 300 | Describe the manufacturing process used to produce common metals. | 2.17 |
| 301 | Care for and repair leather items. | 2.17 |
| 302 | Select and use a wood lathe. | 2.06 |
| 303 | Select and use a wood shaper. | 2.06 |
| 304 | Sharpen hand saws. | 2.06 |
| 305 | Use a gasoline blow torch. | 1.89 |
268 Solder aluminum. 2.72
269 Solder using silver solder. 2.72
270 Construct a board fence. 2.72
271 Select and use a portable router. 2.67
272 Lay bricks. 2.67
273 Explain how metals are heat treated commercially. 2.67
274 Silver braze with an oxy-acetylene torch. 2.67
275 Install cast iron soil pipe. 2.67
276 Use polyethylene film as temporary weatherproofing. 2.65
277 Select and care for rope. 2.61
278 Solder cast iron. 2.59
279 Sharpen circular saw blades. 2.56
280 Draw (lengthen) metal by forging. 2.56
281 Solder using a carbon arc torch. 2.56
282 Tie two ropes together with common knots. 2.56
283 Tie a rope end to hooks, rings and poles. 2.56
284 Plan the location and type of well for a water supply. 2.56
285 Select and maintain a drinking water chlorinator. 2.56
286 Describe the characteristics of hardwood and softwood trees. 2.50
287 Upset (enlarge and shorten) metal by forging. 2.50
288 Select and use a portable power planer. 2.44
289 Sharpen a grass hook or scythe. 2.44
290 Cut metal on an anvil using a hardy or hot cutter. 2.44
291 Discuss the fundamentals of metallurgy. 2.44
292 Make rope slings for materials or animals. 2.44
293 Solder lead (lead burning). 2.41
Use a lock or hook seam to join sheet metal.
Select an electric fence controller.
Construct a barbed-wire fence.
Construct an electric fence.
Plan an agri-business shop.
Anneal metal to remove brittleness.
Normalize metal to achieve uniformity.
Sharpen a baler or forage harvester knife or shear bar.
Construct masonry expansion joints.
Construct a pole building.
Describe the characteristics of common non-ferrous metals.
List and describe the materials used in paint.
Solder stainless steel.
Measure materials and mix concrete by hand.
Season and store lumber.
Use a gas or electric furnace to heat metal.
Read and interpret welding symbols.
Use pulleys and blocks and tackle.
Select and maintain a water softener.
Describe the characteristics of plain- and quarter-sawed lumber.
Select and use a flexible shaft grinder.
Select and use a steam cleaner.
Select and use a metal lathe.
Construct stairs or steps.
Select and use a (non-electric) soldering copper.
219 Explain how moisture in wood affects shrinkage, nail holding ability, strength, etc. 3.00

220 Use a spot welder. 3.00

221 Describe the chemistry of the oxy-acetylene flame and the reaction with the metal in the flame cutting process. 3.00

222 Use a farm pond as a water supply. 3.00

223 Select the size and type of water pump for an application. 3.00

224 Maintain a deep well water system. 3.00

225 Measure and cut glass. 3.00

226 Construct gates and other passageways. 3.00

227 Select and use wood chisels 2.94

228 Select and use a wire or cloth wheel buffer. 2.94

229 Give the actual dimensions of lumber given nominal dimensions. 2.94

230 Describe the characteristics of common ferrous metals. 2.94

231 Select and use rivets. 2.94

232 Weld aluminum. 2.94

233 Use and maintain wire rope. 2.94

234 Use paint and varnish removers. 2.94

235 Select and use a portable orbital sander. 2.89

236 Select and use a portable power hack saw. 2.89

237 Sharpen a mower cutter bar knife. 2.89

238 Measure materials and mix concrete in a batch machine. 2.89

239 Anchor walls or roofs to masonry construction. 2.89

240 Waterproof masonry construction. 2.89

241 Calculate load capacity of beams and columns. 2.89

242 Select and use an anvil, hammer and tongs for working hot metal. 2.89
193 Sharpen hatchets and axes. 3.11
194 Measure materials and mix mortar. 3.11
195 Solder using an oxy-acetylene torch. 3.11
196 Weld stainless steel. 3.11
197 Use a TIG ("Neliarc," Tungsten Inert Gas) welder. 3.11
198 Select and apply paint to concrete surfaces. 3.11
199 Select and use a putty knife. 3.11
200 Select and apply caulking compound. 3.11
201 Plan a home and/or a farm shop. 3.06
202 Select and use a chain saw. 3.06
203 Select and use a belt or disc sander. 3.06
204 Sharpen a wood chisel. 3.06
205 Identify common woods used in agricultural construction. 3.06
206 Select and use timber connectors to fasten wooden members. 3.06
207 Solder a lap, lock, or riveted sheet metal seam. 3.06
208 Use a MIG (CO₂ wire) welder. 3.06
209 Maintain a shallow well system. 3.06
210 Protect a water supply against pollution. 3.06
211 Install galvanized pipe. 3.06
212 Use drawing instruments to make a scale drawing. 3.00
213 Select and use braces and hand drills. 3.00
214 Select and use planes. 3.00
215 Select and use a portable belt sander. 3.00
216 Select and use a portable abrasive cut-off wheel. 3.00
217 Sharpen a plane blade. 3.00
218 Sharpen a chain saw chain. 3.00
| 168 | Solder small holes. | 3.22 |
| 169 | Solder patches on larger holes. | 3.22 |
| 170 | Use glazier's points and glazing compound to install glass. | 3.22 |
| 171 | Plan the location, arrangement and type of fence to use. | 3.22 |
| 172 | Determine the construction of fencing for ends and corners. | 3.22 |
| 173 | Select and use wood files and rasps. | 3.17 |
| 174 | Describe the characteristics of common woods. | 3.17 |
| 175 | Select and apply siding. | 3.17 |
| 176 | Select and use tools to layout metal. | 3.17 |
| 177 | Bend or shape metal using a hammer and anvil. | 3.17 |
| 178 | Bend or twist hot metal in a bench vise. | 3.17 |
| 179 | Harden metal by heat treating. | 3.17 |
| 180 | Temper metal to desired degree of hardness and toughness. | 3.17 |
| 181 | Weld overhead. | 3.17 |
| 182 | Use a carbon arc for brazing, hard surfaceing or heat treating metals. | 3.17 |
| 183 | Oxy-acetylene fusion weld cast iron. | 3.17 |
| 184 | Bend or shape sheet metal with mechanical brakes or rollers. | 3.17 |
| 185 | Describe the operating principles of various water pumps. | 3.17 |
| 186 | Protect plumbing from freezing. | 3.17 |
| 187 | Estimate the amount of paint needed. | 3.17 |
| 188 | Select and use paint rollers. | 3.17 |
| 189 | Plan storage of flammables. | 3.11 |
| 190 | Select and use a jointer. | 3.11 |
| 191 | Select, install and maintain an air compressor. | 3.11 |
| 192 | Select and maintain an oil stone. | 3.11 |
142 Plan for storage and disposal of scrap and waste materials. 3.28
143 Select and use hammers and sledges. 3.28
144 Select and use levels. 3.28
145 Select and use a high pressure washer. 3.28
146 Select and use a planer. 3.28
147 Construct forms for concrete. 3.28
148 Select and use glue and other adhesives to join wood. 3.28
149 Construct wall framing. 3.28
150 Apply plywood or other building boards. 3.28
151 Use an oxy-acetylene flame to heat metal. 3.28
152 Solder cracks in pipes or tubing. 3.28
153 Build up a pad or boss with an arc welder. 3.28
154 Select and install valves and faucets. 3.28
155 Install rigid copper pipe. 3.28
156 Select and apply varnish and lacquer. 3.28
157 Select and apply synthetic finishes. 3.28
158 Identify safety hazards by the use of color coding. 3.28
159 Measure, cut and install clear rigid plastic for windows. 3.24
160 Select and use hand saws. 3.22
161 Select and use a portable tool grinder. 3.22
162 Select and use a band saw. 3.22
163 Sharpen auger bits. 3.22
164 Sharpen a rotary mower blade. 3.22
165 Specify and order ready-mixed concrete. 3.22
166 Lay concrete block. 3.22
167 Select and use an electric soldering iron. 3.22
118 Place and finish concrete.
119 Cure concrete.
120 Select lumber by classification and grade.
121 Describe the characteristics and grades of plywood.
122 Select and use common wood and lag screws to fasten wood.
123 Select and use bolts to fasten wood.
124 Layout a foundation.
125 Build roof trusses.
126 Bend, twist or shape cold metal.
127 Select and use standard threaded fasteners.
128 Describe metal temperature and characteristics by heat colors.
129 Explain how an arc welder operates.
130 Plug holes in metal with an arc welder.
131 Weld sheet metal with an arc welder.
132 Cut cast iron with an oxy-acetylene torch.
133 Cut sheet metal by hand with tin snips, bench shears or chisels.
134 Bend or shape sheet metal with pliers, seamers or with a vise and hammer.
135 Use rivets and riveting tools to join sheet metal.
136 Correct an air or water logged water supply tank.
137 Select the kind and size of pipe to use for a given application.
138 Remove obstructions from traps and drain lines.
139 Identify causes of paint failure.
140 Plan a high school agricultural mechanics shop.
141 Develop a list of desirable tools for various type shops.
093 Select and install hinges, pulls and other miscellaneous building hardware. 3.39
094 Select and use bolt cutters. 3.39
095 Select and use punches and cold chisels. 3.39
096 Select and use thread chasers. 3.39
097 Remove frozen nuts and remove bolts that have broken off. 3.39
098 Select and use an electric soldering gun. 3.39
099 Solder galvanized metal. 3.39
100 Solder copper. 3.39
101 Select, install and maintain an arc welder. 3.39
102 Weld horizontally with the metal in a vertical plane. 3.39
103 Hard surface materials using an arc welder. 3.39
104 Oxy-acetylene fusion weld with filler rod. 3.39
105 Select and use self-tapping screws to join sheet metal. 3.39
106 Select and use plumbing tools. 3.39
107 Identify and select pipe fittings. 3.39
108 Install soft copper pipe. 3.39
109 Install rigid plastic pipe. 3.39
110 Install flexible plastic pipe. 3.39
111 Select the type of paint for a given application. 3.39
112 Select and apply wood preservatives. 3.39
113 Select and apply paint to metal surfaces. 3.39
114 Identify procedures that might insure safety in the handling of materials. 3.39
115 Select and use vises and clamps. 3.35
116 Select and use layout tools for wood. 3.33
117 Estimate the quantity of concrete and materials needed. 3.33
070 Explain the meaning of welder name plate information.
071 Strike and run beads with a D.C. welder.
072 Weld vertically with the metal in a vertical plane.
073 Cut and pierce metal with an arc welder.
074 Explain the principles of fusion and adhesion welding.
075 Select oxy-acetylene welding equipment and supplies.
076 Oxy-acetylene fusion weld without filler rod.
077 Apply hard surfacing using an oxy-acetylene torch.
078 Maintain and repair valves and faucets.
079 List methods to prevent the build-up of carbon monoxide and other fumes.
080 Develop an inventory procedure for control of tools, equipment, supplies and materials.
081 Plan and develop a project work procedure.
082 Make a free-hand sketch utilizing the three principal views.
083 Select materials for project construction.
084 Select and use precision measuring tools such as micrometers.
085 Select and use a portable sabre saw.
086 Select and use a portable electric drill.
087 Sharpen and reshape punches and chisels.
088 Clean and preserve tools.
089 Estimate the number and type of concrete blocks needed.
090 Select the best method of fastening or joining wooden members.
091 Identify building construction members by name.
092 Lay-out and cut rafters.
046. Weld steel castings.  
047. Select proper welding tip size and operating pressures for a given application.  
048. Bronze-weld cast iron.  
049. Prepare paint by mixing, thinning and straining.  
050. List the safety precautions in the use of hand tools.  
051. List safety rules and practices that might prevent falls.  
052. Describe how to prevent and extinguish fires.  
053. Select and use a power hack saw.  
054. Plan storage of tools, equipment, supplies and materials.  
055. Select, specify and order tools, equipment, supplies and materials.  
056. Select and utilize agricultural mechanics training aids and audio-visual materials.  
057. Read or interpret a drawing or plan.  
058. Order materials using common units and designations.  
059. Identify common hand tools by name.  
060. Select and use bits and hand drills.  
061. Select and use a table saw.  
062. Replace handles in tools.  
063. Reinforce concrete.  
064. Select and use various kinds of nails.  
065. Square a board.  
066. Select and apply roofing materials.  
067. Select and use hand hack saws.  
068. Select and use metal files.  
069. Select and use taps and dies.
022 Maintain school shop discipline. 3.56
023 Make a cutting list and a bill of materials. 3.56
024 Select and use a radial arm saw. 3.56
025 Select and use a bench or floor drill press. 3.56
026 Select and use a bench or pedestal grinder. 3.56
027 Select a grinding wheel for tool sharpening. 3.56
028 Dress and true a grinding wheel. 3.56
029 Reshape a screwdriver blade. 3.56
030 Select arc welding equipment, tools and supplies. 3.56
031 List the four fundamentals of welding that control heat. 3.56
032 Make multiple pass welds. 3.56
033 Bronze-weld steel. 3.56
034 Cut or pierce steel with a cutting torch. 3.56
035 Prepare surfaces to be painted. 3.56
036 Identify safety practices in the handling of welding gas cylinders. 3.56
037 Control the use and security of tools, equipment, supplies and materials. 3.50
038 Obtain project plans and select projects for students. 3.50
039 Select and use squares. 3.50
040 Select and use a portable circular saw. 3.50
041 Identify metals by a spark or other type of test. 3.50
042 Specify and order standard steel shapes by name and dimension. 3.50
043 Select and use twist drills. 3.50
044 Select solder and flux for a given application. 3.50
045 Solder using a propane torch. 3.50
Rank Value of CONMAINT Agricultural Mechanics Competencies on a Scale of 1 to 4 as Determined from a Panel of Experts Survey

<table>
<thead>
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<th>Rank</th>
<th>Competency</th>
<th>Value</th>
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<tbody>
<tr>
<td>001</td>
<td>Describe the requirements for eye protection.</td>
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<tr>
<td>002</td>
<td>List safety practices to be observed in the use of power tools.</td>
<td>3.78</td>
</tr>
<tr>
<td>003</td>
<td>Describe the safe behavior of shop workers.</td>
<td>3.72</td>
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<tr>
<td>004</td>
<td>Sharpen twist drills.</td>
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<tr>
<td>005</td>
<td>Strike and run beads with an A.C. welder.</td>
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<tr>
<td>006</td>
<td>Control welding distortion, warping and cracking.</td>
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<tr>
<td>007</td>
<td>Select, use and clean a paint spray gun.</td>
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<tr>
<td>008</td>
<td>Describe the safe dress for shop work.</td>
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<tr>
<td>009</td>
<td>Describe safety procedures to be used with electrical tools, equipment and devices.</td>
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<td>010</td>
<td>Identify first-aid procedures to use in case of an accident.</td>
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<td>011</td>
<td>Estimate project costs.</td>
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<td>012</td>
<td>Calculate board feet.</td>
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<tr>
<td>013</td>
<td>Identify electrodes by a color code and/or an A.W.S. classification number.</td>
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<tr>
<td>014</td>
<td>Select the correct electrode for an application.</td>
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<td>015</td>
<td>Select initial welder heat settings.</td>
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<td>016</td>
<td>Identify weld quality in terms of the four welding fundamentals.</td>
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<tr>
<td>017</td>
<td>Make butt, lap and tee welds.</td>
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<tr>
<td>018</td>
<td>Weld cast iron.</td>
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<tr>
<td>019</td>
<td>Install regulators, hoses and tip. Open tanks, set pressures and check for leaks. Light, adjust and turn off flame.</td>
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</tr>
<tr>
<td>020</td>
<td>Select, use, clean and store paint brushes.</td>
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</tr>
<tr>
<td>021</td>
<td>List safety practices to be used when welding.</td>
<td>3.61</td>
</tr>
</tbody>
</table>
160 Remove and replace bearings. 2.50
161 Disassemble, clean, inspect, repair and assemble hydraulic system components. 2.50
162 Define engine volumetric, mechanical and thermal efficiency. 2.44
163 Clean, inspect and lubricate tracks. 2.44
164 Calculate engine thermal efficiency from measured horsepower and fuel consumption. 2.39
165 Convert energy units from one form to another. (Example: heat energy to mechanical energy.) 2.39
166 Remove and replace gears. 2.39
167 Adjust the steering clutches on a crawler type tractor. 2.35
168 Explain the application of basic laws of thermodynamics to heat engines. 2.33
169 Mount and demount tires. 2.33
170 Remove, disassemble, clean, inspect, repair and assemble a diesel fuel injection pump. 2.28
171 Repair tires and tubes. 2.28
172 Adjust track alignment and tension. 2.28
173 Calibrate a diesel fuel pump on a pump test stand. 2.22
174 Discuss the history and development of agricultural mechanization. 2.11
175 Remove and replace tracks. 1.83
139 Remove, replace and time a diesel fuel injection pump. 2.89
140 List and explain the functions of each component of a magneto spark ignition system. 2.89
141 Adjust a charging system regulator. 2.89
142 Define and calculate the center of gravity of a tractor. 2.89
143 Remove and replace a camshaft and camshaft bearings. 2.83
144 Remove and install an engine crankshaft. 2.83
145 Trace and explain a hydraulic circuit schematic as utilized on an agricultural tractor lift system. 2.83
146 Describe the effects of engine load on engine thermal efficiency. 2.78
147 Remove and replace an engine oil pump. 2.78
148 Remove and install cylinder liners. 2.72
149 Disassemble, clean, inspect, repair and assemble or replace a fuel injection nozzle. 2.72
150 Test and adjust a diesel fuel injection nozzle with a nozzle tester. 2.72
151 Change wheel spacings. 2.72
152 Describe the effects of compression ratio on engine thermal efficiency. 2.67
153 Disassemble, clean, inspect, repair and assemble a starter motor. 2.67
154 Remove and replace a generator (alternator). 2.67
155 Disassemble, clean, inspect, repair and assemble a generator (alternator). 2.67
156 Remove and replace seals. 2.67
157 Remove and replace worn clutch parts. 2.61
158 Use and interpret the readings of an exhaust gas analyzer. 2.59
159 List and describe the functions of the various LP-gas fuel system components. 2.56
117 Explain the importance and the operation of a differential. 3.11
118 Calculate wheel slippage. 3.11
119 Test and diagnose hydraulic system problems. 3.11
120 Calculate horsepower using a prony brake dynamometer. 3.06
121 Remove, clean, inspect and replace pistons. 3.06
122 Use and interpret the readings of a cylinder bore gauge. 3.06
123 Install new rod and main crankshaft bearings. 3.06
124 Sketch and label a valve timing diagram. 3.06
125 Service the cooling system of an air cooled engine. 3.06
126 Explain how the various gear ratios are obtained in a gear type transmission. 3.06
127 List and explain the functions of the various differential parts. 3.06
128 Remove and replace cooling system components: water pump and/or radiator. 3.00
129 List the efficient range of wheel slippage. 3.00
130 Install a new timing gear or chain and time to crankshaft. 2.94
131 Use and interpret the patterns of an oscilloscope to determine ignition system condition. 2.94
132 Define rolling resistance and list the factors that affect it. 2.94
133 List the advantages and disadvantages of various tire sizes, treads and construction. 2.94
134 Define and calculate weight transfer. 2.94
135 Discuss the methods and the effects of modifying tractor engines after purchase to increase engine horsepower. 2.94
136 Discuss the trends in agricultural mechanization. 2.89
137 Remove and replace an oil pan. 2.89
138 Disassemble, clean, inspect, repair and assemble a carburetor. 2.89
096 Explain the operation of multiple-disk, oil bath clutches. 3.22
097 Explain how a hydraulic hydrostatic transmission operates. 3.22
098 Explain how a hydraulic torque converter transmission operates. 3.22
099 Explain the purpose of a differential lock and how it operates. 3.22
100 Explain the Nebraska Tractor Tests and their purpose. 3.22
101 Describe a virtual hitch point and how to find it. 3.18
102 Remove and install piston rings. 3.17
103 Explain how a shift-on-the-go transmission operates. 3.17
104 Explain how a planetary gear type transmission operates. 3.17
105 List the types of final drives and explain their operation. 3.17
106 List the causes and corrections of governor hunting. 3.13
107 Use and interpret the readings of a manometer and/or vacuum gauge in testing an air intake system. 3.12
108 Obtain and interpret Nebraska Tractor Test individual complete reports. 3.12
109 Identify tractor types by classification of fuel used, method of securing traction, wheel arrangement, and purpose of use. 3.11
110 Grind valves and valve seats. 3.11
111 Deglaze and hone cylinder walls. 3.11
112 Remove and replace cooling system components: fan belt, radiator hose and/or thermostat. 3.11
113 Describe the construction of a storage battery and the chemical reaction upon charging or discharging. 3.11
114 Draw an electrical ignition system circuit schematic. 3.11
115 Remove and replace a regulator. 3.11
116 List the various methods of power transmission. 3.11
077 Discuss the safe handling and storage of fuels and lubricants.

078 Discuss the safe transportation of tractors and equipment on the highway by driving and by trucking.

079 Test a storage battery with a voltmeter at a high discharge rate.

080 Determine whether a charging system fault lies with the generator (alternator) or the regulator.

081 Perform general maintenance on a hydraulic system.

082 Define indicated, friction, flywheel, brake, belt, drawbar, PTO and rated horsepower.

083 Define and explain the importance of an engine's lugging ability.

084 Identify engine types by classification of fuel used, valve arrangement, cylinder arrangement, method of cooling and displacement.

085 Determine rod and main crankshaft bearing wear.

086 Use and interpret the readings of a radiator and radiator cap tester.

087 Remove and replace a carburetor and/or fuel pump.

088 Remove and replace a distributor.

089 Explain the purpose and principle of operation of a swinging drawbar.

090 Obtain and interpret Nebraska Tractor Test summaries.

091 Calculate energy, torque, work, power and horsepower given the necessary factors.

092 Remove and replace a starter motor.

093 Sketch a charging system circuit schematic.

094 Use and interpret the readings of a volt-ammeter to test charging system performance.

095 List and describe the functions of the various single-disk, dry clutch parts.
057  List factors to be considered in the selection of tractor options such as engine, transmission, PTO, hitch, hydraulics cab, etc. 3.50

058  Describe the operation and purpose of a supercharger and a turbocharger. 3.44

059  List the effects of adding a turbocharger to an engine not originally equipped with a turbocharger. 3.44

060  Service a liquid cooling system in preparation for cold weather operation. 3.44

061  Explain the air/fuel ratio requirements of an engine for starting, idling, part-load and full-load operation. 3.44

062  Describe the effects of low temperature on battery capacity and engine cranking power requirements. 3.44

063  Explain the meaning of tire dimensions. 3.44

064  Define and explain how to minimize side draft. 3.44

065  Explain the operation of basic hydraulic circuits. 3.44

066  Discuss the safe operation of agricultural and industrial tractors and equipment. 3.44

067  Remove and replace a cylinder head and gasket. 3.39

068  Change the oil and oil filter of an engine. 3.39

069  Remove and replace a diesel fuel injection nozzle. 3.39

070  Remove and install a storage battery. 3.39

071  Clean, visually inspect and add water to a storage battery. 3.39

072  Explain the effect of engine speed and load on optimum spark timing requirements. 3.39

073  Describe how a change in hitch position affects weight transfer and tractor stability. 3.39

074  Define center of pull and center of draft. 3.39

075  Compare the advantages and disadvantages of two-wheel drive, four-wheel drive and crawler type tractors. 3.39

076  List the various types and explain the operation of hydraulic pumps, valves, cylinders, motors, etc. 3.39
038 List the major causes of engine overheating and explain how each might be corrected. 3.56
039 Describe the general operation and function of a gasoline-fueled engine governing system. 3.56
040 Change diesel fuel filters. 3.56
041 List and explain the functions of the various charging system components. 3.56
042 Determine an optimum implement width and tractor size and type given factors of acreage, crops, tillage practices, timeliness, etc. 3.56
043 Define energy, inertia, force, torque, work, power and horsepower. 3.50
044 Explain the importance and function of various types of engine air cleaners. 3.50
045 Service air cleaners and air intake systems. 3.50
046 List and explain the functions of the various engine lubricating system components. 3.50
047 Describe the meaning of oil viscosity index. 3.50
048 List and describe the functions of the various engine liquid cooling system components. 3.50
049 Describe the effects of engine operating temperature on wear rate, power output and fuel consumption. 3.50
050 Set engine high idle rpm by adjusting the governor and/or the governor linkage on a specified engine. 3.50
051 Test the specific gravity of battery electrolyte with a hydrometer. 3.50
052 Select a battery by type and capacity rating for a given application. 3.50
053 List the precautions when jumping or charging batteries. 3.50
054 Adjust tractor engine clutch free travel. 3.50
055 List various methods of extending tractor tire life. 3.50
056 List and explain the basic principles of hydraulics. 3.50
019 Explain the importance of correct valve clearance. 3.67
020 Set valve clearance. 3.67
021 List the functions of oil in a tractor engine. 3.67
022 List and explain the meaning of A.P.I. oil service classifications. 3.67
023 Select an appropriate oil to be used in a tractor engine given the operating and weather conditions. 3.67
024 Calculate transmission input to output shaft ratios given the necessary factors. 3.67
025 Define bore, stroke, displacement and compression ratio. 3.61
026 Calculate displacement and compression ratio given the necessary factors. 3.61
027 List and describe the functions of the various diesel fuel system components. 3.61
028 Explain the importance of keeping diesel fuel clean. 3.61
029 Bleed the air from a diesel fuel system. 3.61
030 List and describe the functions of various starting system components. 3.61
031 Use a dwellmeter to set point gap. 3.61
032 Use and interpret the readings of a coil and condenser tester. 3.61
033 Explain traction changes as affected by dual wheels, inflation, weight on rear wheels, tire size, tire tread, traction conditions, etc. 3.61
034 Determine tractor operating costs of depreciation, interest, taxes, housing, insurance, fuel, lubricants, maintenance and repair. 3.61
035 List and explain the functions of the intake and exhaust system components. 3.56
036 Explain the meaning of a multi-viscosity oil. 3.56
037 Describe the operation and maintenance of the crankcase ventilation system. 3.56
<table>
<thead>
<tr>
<th>Rank</th>
<th>Competency</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>Explain the operation of the float, choke, idling and load system of a carburetor.</td>
<td>3.83</td>
</tr>
<tr>
<td>002</td>
<td>Remove and replace points and condenser.</td>
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</tr>
<tr>
<td>003</td>
<td>Time the distributor with a timing light.</td>
<td>3.78</td>
</tr>
<tr>
<td>004</td>
<td>List and explain the four strokes of a four-stroke cycle engine.</td>
<td>3.72</td>
</tr>
<tr>
<td>005</td>
<td>Determine tractor horsepower using a portable PTO dynomometer.</td>
<td>3.72</td>
</tr>
<tr>
<td>006</td>
<td>List the possible causes of excess engine oil consumption and explain how to determine each.</td>
<td>3.72</td>
</tr>
<tr>
<td>007</td>
<td>Remove and replace a governor.</td>
<td>3.72</td>
</tr>
<tr>
<td>008</td>
<td>List and describe the functions of the various components of the gasoline fuel system.</td>
<td>3.72</td>
</tr>
<tr>
<td>009</td>
<td>Adjust the idle mixture, load mixture and idle speed screws on a carburetor.</td>
<td>3.72</td>
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<tr>
<td>010</td>
<td>List and explain the functions of the various ignition system components.</td>
<td>3.72</td>
</tr>
<tr>
<td>011</td>
<td>Remove, clean, inspect, gap and replace spark plugs.</td>
<td>3.72</td>
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<tr>
<td>012</td>
<td>Determine the cause and correct the failure of an engine to crank and/or start.</td>
<td>3.72</td>
</tr>
<tr>
<td>013</td>
<td>Determine the cause and correct the failure of an engine to run properly or develop horsepower.</td>
<td>3.72</td>
</tr>
<tr>
<td>014</td>
<td>List and explain the two stokes of a two-stroke cycle engine. 3.67</td>
<td>3.67</td>
</tr>
<tr>
<td>015</td>
<td>Compare the two-stroke cycle engine with the four-stroke cycle engine in terms of power, weight, efficiency and application. 3.67</td>
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</tr>
<tr>
<td>016</td>
<td>Identify engine parts by name and function.</td>
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<tr>
<td>017</td>
<td>Use and interpret the readings of a compression gauge.</td>
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<tr>
<td>018</td>
<td>List the precautions in operating a tractor equipped with a turbocharger.</td>
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</table>
### Rank Value of CONMAINT Agricultural Mechanics Subject Matter Categories

on a Scale of 1 to 4 as Determined from a Panel of Experts Survey

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<tr>
<th>Rank</th>
<th>Competency Category</th>
<th>Number of Competencies</th>
<th>Mean Value</th>
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<tr>
<td>01</td>
<td>Safety</td>
<td>14</td>
<td>3.59</td>
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<tr>
<td>02</td>
<td>Project Planning</td>
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<td>03</td>
<td>Arc Welding</td>
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<td>04</td>
<td>Oxy-acetylene Welding</td>
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<tr>
<td>05</td>
<td>Shop and Shop Facilities</td>
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<td>06</td>
<td>Plumbing</td>
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<td>Cold Metal Work</td>
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<td>10</td>
<td>Hand Tools</td>
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<td>11</td>
<td>Woodworking and Construction</td>
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<td>Glazing</td>
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<td>Portable Power Tools</td>
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<td>Field Modification</td>
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APPENDIX C

PANEL OF EXPERTS -- COMPETENCY DATA
469 Identify safety hazards by the use of color coding.

470 List safety precautions in the use of hand tools.

471 List safety practices to be observed in the use of power tools.

472 Describe safety procedures to be used with electrical tools, equipment and devices.

473 List safety rules and practices that might prevent falls.

474 Identify procedures that might insure safety in the handling of materials.

475 Describe how to prevent and extinguish fires.

476 List methods to prevent the build-up of carbon monoxide and other fumes.

477 Identify safety practices in the handling of welding gas cylinders.

478 List the safety practices to be used when welding.

479 Describe the requirements for eye protection.

480 Identify first-aid procedures to use in case of an accident.
448 Select and apply wood preservatives.
449 Select and apply paint to concrete surfaces.
450 Select and apply paint to metal surfaces.
451 Prepare and apply whitewash.
452 Identify causes of paint failure.
453 Use paint and varnish removers.

Glazing
454 Measure and cut glass.
455 Use glazier's points and glazing compound to install glass.
456 Select and use a putty knife.
457 Select and apply caulking compound.
458 Measure, cut and install clear rigid plastic sheet in place of glass.
459 Use polyethylene film as temporary weatherproofing.

Fencing
460 Plan the location, arrangement and type of fence to use.
461 Determine the construction of fencing for ends and corners.
462 Select an electric fence controller.
463 Construct a barbed-wire fence.
464 Construct an electric fence.
465 Construct a board fence.
466 Construct gates and other passageways.

Safety
467 Describe the safe dress for shop work.
468 Describe the safe behaviour of shop workers.
**Plumbing**

425 Select and use plumbing tools.

426 Select the kind and size of pipe to use for a given application.

427 Identify and select pipe fittings.

428 Select and use valves and faucets.

429 Install galvanized pipe.

430 Install rigid copper pipe.

431 Install soft copper pipe.

432 Install rigid plastic pipe.

433 Install flexible plastic pipe.

434 Install cast iron soil pipe.

435 Protect plumbing from freezing.

436 Maintain and repair valves and faucets.

437 Remove obstructions from traps and drain lines.

**Painting**

438 List and describe the materials used in paint.

439 Select the type of paint for a given application.

440 Estimate the amount of paint needed.

441 Prepare surfaces to be painted.

442 Select, use, clean and store paint brushes.

443 Select and use paint rollers.

444 Select, use and clean a paint spray gun.

445 Prepare paint by mixing, thinning and straining.

446 Select and apply varnish and lacquer.

447 Select and apply synthetic finishes.
404 Use rivets and riveting tools to join sheet metal.

405 Select and use self-tapping screws to join sheet metal.

406 Use a lock or hook seam to join sheet metal.

**Rope Work**

407 Select and care for rope

408 Tie two ropes together with common knots.

409 Tie a rope end to hooks, rings and poles.

410 Make slings for materials or animals.

411 Use pulleys and blocks and tackle.

412 Use and maintain wire rope.

**Leather**

413 Care for and repair leather items.

**Water Systems**

414 Plan the location and type of well.

415 Construct and maintain a cistern.

416 Use a farm pond as a water supply.

417 Describe the operating principles of various pumps.

418 Select the size and type of pump for an application.

419 Maintain a shallow well system.

420 Maintain a deep well system.

421 Protect a water supply against pollution.

422 Correct an air or water logged tank.

423 Select and maintain a water softener.

424 Select and maintain a drinking water chlorinator.
383 Use a carbon arc for brazing, hard surfacing or heat treating metals.

384 Use a spot welder.

385 Use a MIG (CO₂ wire) welder.

386 Use a TIG ("Heliarc," Tungsten Inert Gas) welder.

**Oxy-acetylene Welding**

387 Explain the principles of fusion and adhesion welding.

388 Describe the chemistry of the oxy-acetylene flame and the reaction with the metal in the flame cutting process.

389 Select welding equipment and supplies.

390 Select proper tip size and operating pressures for an application.

391 Install regulators, hoses and tip. Open tanks, set pressures and check for leaks. Light, adjust and turn off flame.

392 Fusion weld without filler rod.

393 Fusion weld with filler rod.

394 Bronze-weld steel.

395 Bronze-weld cast iron.

396 Fusion weld cast iron.

397 Cut or pierce steel.

398 Cut cast iron.

399 Apply hard surfacing.

400 Silver braze.

**Sheet Metal**

401 Cut sheet metal by hand with tin snips, bench shears or chisels.

402 Bend or shape sheet metal with pliers, seamers or with a vise and hammer.

403 Bend or shape sheet metal with mechanical brakes or rollers.
358 Explain the meaning of welder name plate information.
359 Identify electrodes by a color code and/or an A.W.S. classification number.
360 Select, install and maintain an arc welder.
361 Select welding equipment, tools and supplies.
362 Select the correct electrode for an application.
363 Select initial welder heat settings.
364 List the four fundamentals of welding that control heat.
365 Strike and run beads with an A.C. welder.
366 Strike and run beads with a D.C. welder.
367 Identify weld quality in terms of the four welding fundamentals.
368 Build up a pad or boss.
369 Make butt, lap and tee welds.
370 Make multiple pass welds.
371 Weld horizontally with the metal in a vertical plane.
372 Weld vertically with the metal in a vertical plane.
373 Weld overhead.
374 Cut and pierce metal.
375 Plug holes.
376 Control distortion, warping and cracking.
377 Weld cast iron.
378 Weld steel castings.
379 Weld sheet metal.
380 Weld stainless steel.
381 Weld aluminum.
382 Hard surface materials.
335 Normalize metal to achieve uniformity.
336 Describe metal temperature and characteristics by heat colors.

Soldering
337 Select the solder and flux for a given application.
338 Select and use a (non-electric) soldering copper.
339 Use a gasoline blow torch.
340 Select and use an electric soldering iron.
341 Select and use an electric soldering gun.
342 Solder using a propane torch.
343 Solder using a carbon arc torch.
344 Solder using an oxy-acetylene torch.
345 Solder small holes.
346 Solder patches on larger holes.
347 Solder cracks in pipes or tubing.
348 Solder a lap, lock, or riveted sheet metal seam.
349 Solder galvanized metal.
350 Solder copper.
351 Solder stainless steel.
352 Solder aluminum.
353 Solder cast iron.
354 Solder lead (lead burning).
355 Solder using silver solder.

Arc Welding
356 Read and interpret welding symbols.
357 Explain how an arc welder operates.
311 Select and use hand hack saws.
312 Select and use bolt cutters.
313 Select and use punches and cold chisels.
314 Select and use files.
315 Select and use twist drills.
316 Select and use taps and dies.
317 Select and use thread chasers.
318 Select and use standard threaded fasteners.
319 Select and use rivets.
320 Remove frozen nuts and remove bolts that have broken off.

Hot Metal Work

321 Select and use an anvil, hammer and tongs for working hot metal.
322 Use a forge fire to heat metal.
323 Use a gas or electric furnace to heat metal.
324 Use an oxy-acetylene flame to heat metal.
325 Draw (lengthen) metal by forging.
326 Upset (enlarge and shorten) metal by forging.
327 Bend or shape metal using a hammer and anvil.
328 Cut metal on an anvil using a hardy or hot cutter.
329 Bend or twist hot metal in a bench vise.
330 Discuss the fundamentals of metallurgy.
331 Explain how metals are heat treated commercially.
332 Harden metal by heat treating.
333 Temper metal to desired degree of hardness and toughness.
334 Anneal metal to remove brittleness.
287 Select and use common wood and lag screws to fasten wood.
288 Select and use bolts to fasten wood.
289 Select and use timber connectors to fasten wood.
290 Select and use glue and other adhesives to join wooden members.
291 Square a board.
292 Layout a foundation.
293 Identify building construction members by name.
294 Construct wall framing
295 Apply plywood or other building boards.
296 Select and apply siding.
297 Lay-out and cut rafters.
298 Build trusses.
299 Select and apply roofing materials.
300 Construct stairs or steps.
301 Calculate the load capacity of beams and columns.
302 Construct a pole building.
303 Select and install hinges, pulls and other miscellaneous building hardware.

**Cold Metal Work**
304 Describe the manufacturing process used to produce common metals.
305 Describe the characteristics of common ferrous metals.
306 Describe the characteristics of common non-ferrous metals.
307 Identify metals by a spark or other type of test.
308 Specify and order standard steel shapes by name and dimension.
309 Select and use metal layout tools.
310 Bend, twist or shape cold metal.
264 Construct forms for concrete.
265 Reinforce concrete.
266 Place and finish concrete.
267 Cure concrete.
268 Estimate the number and type of concrete blocks needed.
269 Measure materials and mix mortar.
270 Lay concrete blocks.
271 Lay bricks.
272 Construct masonry expansion joints.
273 Anchor walls or roofs to masonry construction.
274 Waterproof masonry construction.

Woodworking and Construction
275 Describe the characteristics of hardwood and softwood trees.
276 Identify common woods used in agricultural construction.
277 Describe the characteristics of common woods.
278 Describe the characteristics of plain- or quarter-sawn lumber.
279 Explain how moisture in wood affects shrinkage, nail holding ability, strength, etc.
280 Season and store lumber.
281 Select lumber by classification and grade.
282 Calculate board feet.
283 Give the actual dimensions of lumber given nominal dimensions.
284 Select the best method of fastening or joining wooden members.
285 Describe the characteristics and grades of plywood.
286 Select and use various kinds of nails.
Tool Fitting
241 Select a grinding wheel for tool sharpening.
242 Dress and true a grinding wheel.
243 Select and maintain an oil stone.
244 Sharpen a plane blade.
245 Sharpen a wood chisel.
246 Reshape a screwdriver blade.
247 Sharpen and reshape punches and chisels.
248 Sharpen auger bits.
249 Sharpen twist drills.
250 Sharpen hatchets and axes.
251 Sharpen a grass hook or scythe.
252 Sharpen a rotary mower blade.
253 Sharpen a mower cutter bar knife.
254 Sharpen a baler or forage harvester knife or shear bar.
255 Sharpen hand saws.
256 Sharpen circular saw blades.
257 Sharpen a chain saw chain.
258 Replace handles in tools.
259 Clean and preserve tools.

Masonry
260 Estimate the quantity of concrete and materials needed.
261 Measure materials and mix concrete by hand.
262 Measure materials and mix concrete in a batch machine.
263 Specify and order ready-mixed concrete.
218 Select and use a portable router.
219 Select and use a portable power planer.
220 Select and use a portable power hack saw.
221 Select and use a portable abrasive cut-off wheel.
222 Select and use a steam cleaner.
223 Select and use a high pressure washer.
224 Select and use a chain saw.

Stationary Power Tools
225 Select and use a table saw.
226 Select and use a radial arm saw.
227 Select and use a bench or floor drill press.
228 Select and use a band saw.
229 Select and use a power hack saw.
230 Select and use a jointer.
231 Select and use a planer.
232 Select and use a wire or cloth wheel buffer
233 Select and use a wood lathe.
234 Select and use a metal lathe.
235 Select, install, and maintain an air compressor.
236 Select and use a bench or pedestal grinder.
237 Select and use a belt or disc sander.
238 Select and use a wood shaper.
239 Select and use a metal shaper.
240 Select and use a milling machine.
195 Estimate project costs.
196 Order materials using common units and designations.

**Hand Tools**

197 Identify common hand tools by name.
198 Select and use hammers and sledges.
199 Select and use hand saws.
200 Select and use axes and hatchets.
201 Select and use braces and hand drills.
202 Select and use bits and drills.
203 Select and use planes.
204 Select and use wood chisels.
205 Select and use wood files and rasps.
206 Select and use vises and clamps.
207 Select and use squares.
208 Select and use levels.
209 Select and use precision measuring tools. (micrometers)
210 Select and use wood layout tools.

**Portable Power Tools**

211 Select and use a portable sabre saw.
212 Select and use a portable circular saw.
213 Select and use a portable electric drill.
214 Select and use a portable orbital sander.
215 Select and use a portable belt sander.
216 Select and use a portable tool grinder.
217 Select and use a flexible shaft grinder.
Shop and Shop Facilities

176 Plan a home and/or a farm shop.
177 Plan an agri-business shop.
178 Plan a high school agricultural mechanics shop.
179 Develop a list of desirable tools for various type shops.
180 Plan storage of tools, equipment, supplies and materials.
181 Plan storage of flammables.
182 Plan for storage and disposal of scrap and waste materials.
183 Develop an inventory procedure for control of tools, equipment, supplies and materials.
184 Control the use and security of tools, equipment, supplies and materials.
185 Select, specify and order tools, equipment, supplies and materials.
186 Maintain school shop discipline.
187 Select and utilize agricultural mechanics training aids and audio-visual materials.

Project Planning

188 Obtain project plans and select projects for students.
189 Read or interpret a drawing or plan.
190 Plan and develop a project work procedure.
191 Make a free-hand sketch utilizing the three principal views.
192 Use drawing instruments to make a scale drawing.
193 Select materials for project construction.
194 Make a cutting list and a bill of materials.
Trace and explain a hydraulic circuit schematic as utilized on an agricultural tractor lift system.

Test and diagnose hydraulic system problems.

Disassemble, clean, inspect, repair and assemble hydraulic system components.

Field Modification

Discuss the methods and the effects of modifying tractor engines after purchase to increase engine horsepower.

Nebraska Tractor Tests

Explain the Nebraska Tractor Tests and their purpose.

Obtain and interpret Nebraska Tractor Test summaries.

Obtain and interpret Nebraska Tractor Test individual complete reports.

Troubleshooting

Determine the cause and correct the failure of an engine to crank and/or start.

Determine the cause and correct the failure of an engine to run properly or develop horsepower.

Safety

Discuss the safe handling and storage of fuels and lubricants.

Discuss the safe operation of agricultural and industrial tractors and equipment.

Discuss the safe transportation of tractors and equipment on the highway by driving and by trucking.
147 Adjust track alignment and tension.
148 Remove and replace tracks.

**Hitches and Hitching**

149 Define and calculate the center of gravity of a tractor.
150 Define and calculate weight transfer.
151 Describe how a change in hitch position affects weight transfer and tractor stability.
152 Define center of pull and center of draft.
153 Define and explain how to minimize side draft.
154 Describe a virtual hitch point and how to find it.
155 Explain the purpose and principle of operation of a swinging drawbar.

**Selection and Economics**

156 Determine an optimum implement width and tractor size and type give factors of acreage, crops, tillage practices, timeliness, etc.
157 Determine tractor operating costs of depreciation, interest, taxes, housing, insurance, fuel, lubricants, maintenance and repair.
158 List factors to be considered in the selection of tractor options such as engine, transmission, PTO, hitch, hydraulics, cab, etc.
159 Compare the advantages and disadvantages of two-wheel drive, four-wheel drive and crawler type tractors.

**Hydraulics**

160 List and explain the basic principles of hydraulics.
161 Explain the operation of basic hydraulic circuits.
162 List the various types and explain the operation of hydraulic pumps, valves, cylinders, motors, etc.
163 Perform general maintenance on a hydraulic system.
Differentials and Final Drives

128 List and explain the function of the various differential parts.

129 Explain the importance and operation of a differential.

130 Explain the purpose of a differential lock and how it operates.

131 List the types of final drives and explain their operation.

General Power Transmission

132 Remove and replace gears.

133 Remove and replace bearings.

134 Remove and replace seals.

Tires and Traction

135 List the various methods of extending tire life.

136 Explain the meaning of tire dimensions.

137 Explain traction changes as affected by dual wheels, inflation, weight on rear wheels, tire size, tire tread, traction conditions, etc.

138 Define rolling resistance and list factors that affect it.

139 List the efficient range of wheel slippage.

140 Calculate wheel slippage.

141 Change wheel spacings.

142 Mount and demount tires.

143 Repair tires and tubes.

144 List the advantages and disadvantages of various tire sizes, treads and construction.

Tracks

145 Adjust the steering clutches on a crawler type tractor.

146 Clean, inspect and lubricate tracks.
Electrical Charging System

109 List and explain the functions of the various charging system components.

110 Sketch a charging system circuit schematic.

111 Use and interpret the readings of a volt-ammeter to test charging system performance.

112 Determine whether a charging system fault lies with the generator (alternator) or the regulator.

113 Adjust a charging system regulator.

114 Remove and replace a regulator.

115 Remove and replace a generator (alternator).

116 Disassemble, clean, inspect, repair and assemble a generator (alternator).

Clutches

117 List and describe the functions of the various single-disk, dry clutch parts.

118 Explain the operation of multiple-disk, oil bath clutches.

119 Adjust tractor drive clutch free travel.

120 Remove and replace worn clutch parts.

Transmissions

121 List the various methods of power transmission.

122 Calculate input to output shaft ratios given the necessary factors.

123 Explain how the various gear ratios are obtained in a gear type transmission.

124 Explain how a high-low shift-on-the-go transmission operates.

125 Explain how a planetary gear type transmission operates.

126 Explain how a hydraulic hydrostatic transmission operates.

127 Explain how a hydraulic torque converter transmission operates.
089 Clean, visually inspect and add water to a storage battery.
090 Test the specific gravity of the electrolyte with a hydrometer.
091 Test the battery with a voltmeter at a high discharge rate.
092 Select a battery by type and capacity rating for a given application.
093 List the precautions when jumping or charging batteries.
094 Describe the effects of low temperature on battery capacity and engine cranking power requirements.
095 List and describe the functions of various starting system components.
096 Remove and replace a starter motor.
097 Disassemble, clean, inspect, repair and assemble a starter motor.

**Electrical Ignition System**

098 List and explain the functions of the various ignition system components.
099 Draw an electrical ignition system circuit schematic.
100 Explain the effect of engine speed and load on optimum spark timing requirements.
101 Remove and replace points and condenser.
102 Use a dwellmeter to set point gap.
103 Time the distributor with a timing light.
104 Remove and replace a distributor.
105 Remove, clean, inspect, gap and replace spark plugs.
106 Use and interpret the readings of a coil and condenser tester.
107 Use and interpret the patterns of an oscilloscope to determine ignition system condition.
108 List and explain the functions of each component of a magneto spark ignition system.
072 Adjust the idle mixture, load mixture and idle speed screw on a carburetor.
073 Remove and replace a carburetor and/or fuel pump.
074 Disassemble, clean, inspect, repair and assemble a carburetor.
075 Use and interpret the readings of an exhaust gas analyzer.

**LP-Gas Fuel System**

076 List and describe the functions of the various LP-gas fuel system components.

**Diesel Fuel System**

077 List and describe the functions of the various diesel fuel system components.
078 Explain the importance of keeping diesel fuel clean.
079 Change diesel fuel filters.
080 Bleed the air from a diesel fuel system.
081 Remove and replace a diesel fuel injection nozzle.
082 Disassemble, clean, inspect, repair and assemble or replace a fuel injection nozzle.
083 Test and adjust a diesel fuel injection nozzle with a nozzle tester.
084 Remove, replace and time a diesel fuel injection pump.
085 Remove, disassemble, clean, inspect, repair and assemble a diesel fuel injection pump.
086 Calibrate a diesel fuel pump on a pump test stand.

**Electrical Starting System**

087 Describe the construction of a storage battery and the chemical reaction upon charging or discharging.
088 Remove and install a battery.
Cooling Systems

057 List and describe the functions of the various engine liquid cooling system components.

058 Remove and replace cooling system components: fan belt, radiator hose and/or thermostat.

059 Remove and replace cooling system components: water pump and/or radiator.

060 Service a liquid cooling system in preparation for cold weather operation.

061 Service the cooling system of an air cooled engine.

062 Use and interpret the readings of a radiator and radiator cap tester.

063 Describe the effects of engine operating temperature on wear rate, power output and fuel consumption.

064 List the major causes of engine overheating and explain how each might be corrected.

Governing System (Spark-ignition engines)

065 Describe the general operation and function of an engine governing system.

066 Set engine high idle rpm by adjusting the governor and/or the governor linkage on a specified engine.

067 Remove and replace a governor.

068 List the causes and corrections of governor hunting.

Gasoline Fuel Systems

069 List and describe the functions of the various components of the fuel system.

070 Explain the air/fuel ratio requirements of an engine for starting, idling, part-load and full-load operation.

071 Explain the operation of the float, choke, idling and load system of a carburetor.
038 Service air cleaners and air intake systems.

039 Describe the operation and purpose of a supercharger and a turbocharger.

040 List the effects of adding a turbocharger to an engine not originally equipped with a turbocharger.

041 List the precautions in operating a tractor equipped with a turbocharger.

042 Use and interpret the readings of a manometer and/or vacuum gauge in testing an air intake system.

043 Sketch and label a valve timing diagram.

044 Explain the importance of correct valve clearance.

045 Set valve clearance.

Lubrication Systems

046 List the functions of oil in a tractor engine.

047 List and explain the functions of the various engine lubricating system components.

048 List and explain the meaning of A.P.I. oil service classifications.

049 Describe the meaning of oil viscosity index.

050 Explain the meaning of a multi-viscosity oil.

051 Select an appropriate oil to be used in a tractor engine given the operating and weather conditions.

052 Change the oil and oil filter of an engine.

053 Remove and replace an oil pan.

054 Remove and replace an engine oil pump.

055 List the possible causes of excess engine oil consumption and explain how to determine each.

056 Describe the operation and maintenance of the crankcase ventilation system.
019 Define and explain the importance of an engine's lugging ability.

Classification

020 Identify tractor types by classification of fuel used, method of securing traction, wheel arrangement and purpose of use.

021 Identify engine types by classification of fuel used, valve arrangement, cylinder arrangement, method of cooling and displacement.

Basic Engine

022 Identify engine parts by name and function.

023 Use and interpret the readings of a compression gauge.

024 Remove and replace a cylinder head and gasket.

025 Grind valves and valve seats.

026 Install a new timing gear or chain and time to crankshaft.

027 Remove and replace a camshaft and camshaft bearings.

028 Remove, clean, inspect and replace pistons.

029 Remove and install piston rings.

030 Deglaze and hone cylinder walls.

031 Use and interpret the readings of a cylinder bore gauge

032 Remove and install cylinder liners.

033 Determine rod and main crankshaft bearing wear.

034 Install new rod and main crankshaft bearings.

035 Remove and install an engine crankshaft.

Intake and Exhaust Systems

036 List and explain the functions of the intake and exhaust system components.

037 Explain the importance and function of various types of air cleaners.
I - POWER FOR AGRICULTURAL OPERATIONS - AGRICULTURAL ENGINEERING 230

History and Development

001 Discuss the history and development of agricultural mechanization.

002 Discuss the trends in agricultural mechanization.

Engine Fundamentals

003 List and explain the four strokes of a four-stroke cycle engine.

004 List and explain the two strokes of a two-stroke cycle engine.

005 Compare the two-stroke cycle engine with the four-stroke cycle engine in terms of power, weight, efficiency and application.

006 Define bore, stroke, displacement and compression ratio.

007 Calculate displacement and compression ratio given the necessary factors.

008 Define energy, inertia, force, torque, work, power and horsepower.

009 Calculate energy, torque, work, power and horsepower given the necessary factors.

010 Define indicated, friction, flywheel, brake, belt, drawbar, PTO and rated horsepower.

011 Define engine volumetric, mechanical and thermal efficiency.

012 Calculate engine thermal efficiency from measured horsepower and fuel consumption.

013 Convert energy units from one form to another. (Example: heat energy to mechanical energy.)

014 Explain the application of basic laws of thermodynamics to heat engines.

015 Calculate horsepower using a prony brake dynamometer.

016 Determine tractor horsepower using a portable PTO dynamometer.

017 Describe the effects of compression ratio on engine thermal efficiency.

018 Describe the effects of engine load on engine thermal efficiency.
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INSTRUCTIONS

Try to allow a period of approximately one hour to indicate your responses.

Consider the subject matter rather than behavioral objective words such as: explain, list, identify, describe, discuss, etc.

Your reaction to each competency should be based on your agreement or disagreement that the competency should be a part of the course content of Agricultural Engineering 230 (Power for Agricultural Operations) or Agricultural Engineering 240 (Teaching Agricultural Construction and Maintenance), the two specified Agricultural Engineering courses that are required for undergraduates majoring in Agricultural Education at The Ohio State University.

Rank your response as follows:

SA - Strongly agree
A - Agree
D - Disagree
SD - Strongly disagree

Please circle your answer

EXAMPLE:

List of competencies Answer sheet
925 Replace wooden spokes in wagon wheels. 925 SA A D SD
926 List effective teaching procedures. 926 SA A D SD

Try to choose one of the four options if possible. If there are words that have no meaning to you, or competencies that are not clear, circle all options.

927 Identify a correct accumulator span. 927 SA A D SD

Try to complete your answers within a week and return only this section in the envelope provided.
The 22 subject matter sub-areas of competencies for the Agricultural Engineering 240 course (CONMAINT) were as follows:

<table>
<thead>
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<th>Subject Matter Sub-Area</th>
<th>Competence</th>
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<tr>
<td>Shop and shop facilities</td>
<td>Arc welding</td>
</tr>
<tr>
<td>Project planning</td>
<td>Oxy-acetylene welding</td>
</tr>
<tr>
<td>Hand tools</td>
<td>Sheet metal</td>
</tr>
<tr>
<td>Portable power tools</td>
<td>Rope work</td>
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<tr>
<td>Stationary power tools</td>
<td>Leather</td>
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<tr>
<td>Tool fitting</td>
<td>Water systems</td>
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<tr>
<td>Masonry</td>
<td>Plumbing</td>
</tr>
<tr>
<td>Woodworking and construction</td>
<td>Painting</td>
</tr>
<tr>
<td>Cold metal work</td>
<td>Glazing</td>
</tr>
<tr>
<td>Hot metal work</td>
<td>Fencing</td>
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<tr>
<td>Soldering</td>
<td>Safety</td>
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</table>
The 27 subject matter sub-areas of competencies for the Agricultural Engineering 230 (POWER) course were as follows:

- History and development
- Engine fundamentals
- Classification
- Basic engine
- Intake and exhaust system
- Lubrication system
- Cooling system
- Governing system
- Gasoline fuel system
- LP-gas fuel system
- Diesel fuel system
- Electrical starting system
- Electrical ignition system
- Electrical charging system
- Clutches
- Transmissions
- Differentials and final drives
- General power transmission
- Tires and traction
- Tracks
- Hitches and hitching
- Selection and economics
- Hydraulics
- Field modification
- Nebraska Tractor Tests
- Troubleshooting
- Safety
APPENDIX B

PANEL OF EXPERTS -- INSTRUMENT
FOLLOW-UP LETTER TO PANEL OF EXPERTS

107 Nottingham Ct.
Blacksburg, VA 24060
March 29, 1974

Mr. David Abbott
Vocational Agriculture Instructor
Tecumseh High School
9830 W. National Road
New Carlisle, OH 45344

Dear Dave:

By now you should have received a questionnaire from me. If for some reason you haven't, please let me know and I'll be happy to send you one.

Would you please take time to indicate your responses and return them to me so that I can include the benefit of your experiences and opinions in this study? I hope to have all returns in by April 5th.

If you have already sent your reply, please excuse this letter and accept my thanks.

Sincerely,

Miles H. Lovingood

Miles H. Lovingood
March 15, 1974

Memo to: Members of the Agricultural Mechanics Panel of Experts

From: Carlton E. Johnson, Professor, Department of Agricultural Engineering

You have been recommended and have been asked as the representative of your district to join Dr. Wilson, Dick Hummel, Sam Huber and myself as a member of a panel of experts on agricultural mechanics to evaluate competencies that might be taught Agricultural Education majors in their required Agricultural Engineering courses, 230 (Power for Agricultural Operations) and 240 (Teaching Agricultural Construction and Maintenance).

You should have received, or will receive in a few days, a questionnaire from Miles Lovingood, the graduate student conducting this study. The questionnaire consists of a fairly comprehensive list of competencies that vocational agriculture teachers might use that fall under the subject matter areas covered by Agricultural Engineering 230 and 240. From your reactions, along with those of other panel members, it will be possible to determine the agricultural mechanics competencies that are of importance to teachers and might be emphasized at the undergraduate level.

I hope you will take this opportunity to respond to this questionnaire. As an experienced teacher in the area of agricultural mechanics your opinions are invaluable and will contribute toward a better understanding of teacher needs.

Thanks for your help.

CEJ/w

cc: Dr. R. E. Bender
    Dr. J. R. Warmbrod
    Dr. Richard H. Wilson
    Mr. Richard Hummel
    Professor S. G. Huber
March 7, 1974

To: Selected Vocational Agriculture Instructors

Fr: Miles Lovingood

Enclosed is a list of competencies that I indicated would be sent to you in my previous letter.

The purpose of this part of the study is to determine a selected number of competencies that you, and other members of the panel of experts, agree should be a part of the course content of the Agricultural Engineering courses required for undergraduate Agricultural Education majors. This recommended list will then be submitted to teachers with less than five years experience to determine if they did acquire these competencies. By this method I hope to confirm the agricultural mechanics course content at Ohio State that is satisfactory and recommend changes or additions otherwise.

Because of your expertise, and the relatively small number on the panel, be assured that your participation in this study is vital. Although it is necessary that I know the identity of each respondent to assure geographical representation, your reactions will be confidential and used only as a part of the overall response of the panel. I believe that you will agree that your input is important and that as a result some recommendations for change may be considered.

Please refer to the instruction page and after you have indicated your reactions to the competencies, return the answer sheets to me in the self-addressed, stamped envelope provided.

Your participation in this study will be appreciated.
Mr. T. Dwain Sayre, Instructor  
Vocational Agriculture  
Mohawk High School  
Rt. # 3  
Sycamore, Ohio 44882  

Dear Dwain:  

You have been recommended by your area supervisor as the teacher who might best represent your area on a panel of experts in a study concerning the required pre-service agricultural mechanics courses taught in the Department of Agricultural Engineering at The Ohio State University.  

In a few days I will be mailing you a list of agricultural mechanics competencies for your reactions along with more information about the study.  

Since the panel of experts will be composed of fewer than 20 people, your response will carry considerable weight. I hope you will accept the challenge of serving on this panel of experts.  

Sincerely,  

Miles H. Lovingood
MEMBERS OF THE AGRICULTURAL MECHANICS PANEL OF EXPERTS

Carlton E. Johnson, Professor, Department of Agricultural Engineering
Samuel G. Huber, Professor, Department of Agricultural Engineering
Richard H. Wilson, Professor, Department of Agricultural Education
Richard S. Hummel, Area Supervisor, Department of Agricultural Education

Experienced Teachers of Vocational Agriculture:

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<th>Teacher</th>
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<td>Clyde Stout</td>
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<td>Larry Heintz</td>
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<td>Oak Harbor</td>
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<td>Dwain Sayre</td>
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<td>Jack Nowells</td>
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<td>Gerald Pope</td>
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Nomination of vocational production agriculture teacher to serve on a panel of advisors to identify agricultural mechanics skills that a prospective teacher should acquire as a result of the required Agricultural Engineering courses at The Ohio State University.

CRITERIA:

1. A vocational agriculture teacher teaching full-time in the production taxonomy.

2. An experienced teacher with approximately five or more years of service.

3. A teacher with a well-balanced curriculum. This teacher should be competent in teaching agricultural mechanics, but it should not dominate his curriculum.

DISTRICT

TEACHER

ALTERNATE

DISTRICT

TEACHER

ALTERNATE

Return to: Miles H. Lovingood, 107 Nottingham Ct., Blacksburg, Va. 24060
Mr. Welch Barnett
Area Supervisor
Agricultural Education Department
Agricultural Administration Building
2120 Fyffe Road
The Ohio State University
Columbus, Ohio 43210

Dear Welch:

I am attempting to complete my Ph.D. program under the advisement of Dr. Bender and Dr. Johnson by an evaluation of the pre-service agricultural engineering courses required of agricultural education majors at Ohio State.

As an initial part of this study, I would like to use a panel of advisers to identify some basic agricultural mechanics skills that should be acquired by prospective teachers of production agriculture prior to graduation from college. This panel will consist of selected supervisors, teacher educators, and vocational agriculture teachers from each of the 14 Ohio districts.

Would you assist me, please, by naming one teacher and one alternate from each of the districts or district that you supervise based on the criteria on the enclosed sheet and return it to me?

Your help will be appreciated.

Sincerely,

Miles H. Lovingood
APPENDIX A

PANEL OF EXPERTS -- CORRESPONDENCE


Guiler, Gilbert S. "How First Year Teachers Perceive Their Abilities." The Agricultural Education Magazine, 42 (June, 1970), 312-313.


REFERENCES CITED

"Agricultural Production Program and Departmental Requirements," Department of Agricultural Education, College of Agriculture and Home Economics, The Ohio State University, Columbus, September, 1973. (mimeographed)


A University Department Evaluates Its Curriculum . . . An Evaluation of the Curriculum in Agricultural Education at The Ohio State University. Department of Agricultural Education, College of Agriculture, The Ohio State University, Columbus, 1958.


3. Agricultural mechanics competencies might be grouped into categories by origin of acquisition in an effort to ascertain the existence of any type or level of competency found predominantly in such a division.

4. More study should be undertaken to determine why only 66 percent of the relatively new teachers teach the more important agricultural mechanics competencies recommended in the panel of experts survey.

5. Because limitations on time may preclude including all of the more important agricultural mechanics competencies in this study in the pre-service courses taught in the Agricultural Engineering Department, further research might establish which competencies could best be taught for college level credit within the constraints of time and facilities.
and taught or used by 50 percent or more of the teachers receive more emphasis in pre-service courses taught in the Agricultural Engineering Department.

3. That specific agricultural mechanics competencies acquired on the job by the greater percentage of the teachers surveyed than from any other source be considered for inclusion in the pre-service courses taught in the Agricultural Engineering Department.

4. That the specific agricultural mechanics competencies not taught by a majority of the teachers surveyed be examined for possible inclusion or exclusion in the pre-service courses taught in the Agricultural Engineering Department.

5. That areas not currently taught or determined to be weak by this study be considered for inclusion in in-service education classes.

Recommendations for Further Study

1. The relationships of various groups toward the inclusion of selected agricultural mechanics competencies in pre-service courses taught in the Agricultural Engineering Department might bear further study. For example: Do teacher educators and experienced teachers agree upon the importance of specific agricultural mechanics competencies? Do relatively new teachers and experienced teachers believe that the same agricultural mechanics competencies are equally important?

2. The agricultural mechanics competencies that a large number of teachers indicated would require much study and assistance to teach might be further investigated to determine the reasons for difficulty.
Conclusions

1. The panel of experts composed primarily of experienced teachers of vocational production agriculture is likely to agree that almost any agricultural mechanics competency should be taught in the pre-service courses taught in the Agricultural Engineering Department.

2. About one-half of the relatively new teachers of vocational production agriculture required some to much study and assistance to teach or use the agricultural mechanics competencies included in this study.

3. Relatively new teachers of vocational production agriculture acquired the selected agricultural mechanics competencies included in this study from a variety of sources. Primarily, competencies were acquired on the job; secondarily, from college learning experiences.

4. About two-thirds of the relatively new teachers were teaching or performing the more important agricultural mechanics competencies included in the survey.

Recommendations

1. That the pre-service courses in agricultural engineering required of prospective teachers of vocational agriculture be organized to include as many as possible and practical of the more desirable agricultural mechanics competencies found from the results of the panel of experts survey.

2. That specific agricultural mechanics competencies requiring some to much study and assistance by 50 percent or more of the teachers
Agricultural Operations, in addition to the two required courses. No other course taught in the Agricultural Engineering Department was elected by as many as 25 percent of the teachers. On the average, only one of every two respondents elected one course involving agricultural mechanics beyond the curriculum requirements.

Findings

As a whole, teachers were nearly evenly divided as to the amount of preparation needed to teach or use the agricultural mechanics competencies in this study. About half of the teachers responded that they would require little study and assistance and half would require some to much assistance to teach or use the competencies. However, teachers had acquired the competencies from a variety of sources. Just over one-third of the teachers (34 percent) had acquired these selected agricultural mechanics competencies on the job. Nearly one quarter (23 percent) had acquired the competencies during work experience. The teachers' own high school experience was not a major source of competency acquisition, with only 16 percent of the teachers indicating this source. Only 29 percent of the teachers had acquired these competencies during their pre-service college education. Generally, two-thirds (66 percent) of the teachers were teaching the competencies, but fewer than should be if results of the panel of experts survey reflected important competencies for teachers to possess and teach.
attempt was made to select or limit competencies within the subject matter areas involved. These competencies were then submitted to a panel of 18 experts which included 14 experienced teachers of vocational production agriculture recommended by area supervisors, one supervisor of vocational agriculture teachers, one teacher educator from the Department of Agricultural Education, and two professors from the Department of Agricultural Engineering. The panel of experts reacted to each competency to establish the degree of agreement that the competency should be taught in the two courses taught in the Agricultural Engineering Department and required for prospective teachers. The responses were assigned values and the competencies ranked. The mean of the responses of the panel of experts to the list of competencies indicated that they "agreed" or "strongly agreed" that 448 (93 percent) of the 480 competencies should be taught in either the "Power for Agricultural Operations" course or the course titled "Teaching of Agricultural Construction and Maintenance." The 240 highest ranking competencies were selected for further analysis by young teachers.

Second-, third-, and fourth-year teachers were identified and divided randomly into two groups, each of which received 120 of the highest ranking competencies. These teachers had a mean of three years of teaching experience. The study was limited to these teachers on the assumption that they had been on the job long enough to have had sufficient experience teaching agricultural mechanics competencies, yet still would recall which of the competencies they had acquired during work experiences, high school, or college. While in college, nearly 50 percent had elected to take Agricultural Engineering 250, Machines for
CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

As agricultural machines become larger, more complex, and more sophisticated, the task of teaching agricultural mechanics by the vocational agriculture teacher has escalated accordingly. The need for more and better preparation of teachers in agricultural mechanics competencies has been well documented. The purpose of this study was to determine some of the more important agricultural mechanics competencies that prospective teachers of vocational production agriculture should acquire in the two specifically required courses taught in the Agricultural Engineering Department during their pre-service education. Additional objectives of this study were to examine a selected list of these important competencies to find the amount of study and assistance required to teach or use them, where they had been acquired, and whether teachers were using them.

Methodology

To achieve these objectives, a comprehensive list of 480 agricultural mechanics competencies in the subject matter area of agricultural power and agricultural construction and maintenance was developed from textbooks, previous studies, and from direct observation by the writer while auditing the two required pre-service courses. No
gain competencies in determining bearing and cylinder wear, ordering parts, and overhauling a small engine. Many of the above competencies are included in the competencies shown in Table 32 as needing increased emphasis or addition in the POWER subject matter area.

In the CONMAINT subject matter area, a required course, previously Agricultural Engineering 240, was reorganized into Agricultural Mechanization and Systems 240 emphasizing metal fabrication and a second course, Agricultural Mechanization and Systems 241, primarily involving wood fabrication, was added. These two courses are not limited to agricultural education students, therefore do not include project planning or methods of teaching. This revision allowed the expansion of some areas and addition of plumbing, tool fitting, cold metal working, sheet metal, soldering, hand and power tools, concrete and masonry, wood construction, and painting and preservatives. Many of the competencies shown in Table 33 as requiring some to much preparation by at least 50 percent of the teachers and taught by at least 50 percent of the teachers have received additional emphasis or were added as a result of the revision of one course and the addition of a second.

There is yet a need for the inclusion of a methods course in the areas of shop and shop facilities and project planning. However, in-service education courses include a workshop in Agricultural Mechanization and Systems 591 and a Practicum in Teaching Agricultural Mechanics, Agricultural Education 743, in which teachers may influence the course content dependent upon their specific needs.
In final summary, slightly over half of the teachers in this study would require some to much preparation to teach or use selected POWER and CONMAINT agricultural mechanics competencies. Nearly one-third of the teachers had acquired competencies on the job, followed by college, work experience, and high school, in that order. An average of nearly two-thirds of the teachers taught or used the competencies.

Agricultural Mechanics Course Revisions

Since the time this study was conducted, the pre-service agricultural mechanics program of instruction for prospective teachers of vocational agriculture in Ohio was revised. Instead of nine total credit hours, the curriculum in 1976-77 required prospective teachers to take 10 specified quarter credit hours and elect three (3) quarter credit hours in a newly specified Agricultural Mechanization and Systems Division of the Department of Agricultural Engineering. The addition of four (4) credit hours increased the percentage of agricultural mechanics subject matter courses from 16 to over 23 percent of the technical course requirements and from 6 to nearly 7 percent of the total curriculum requirements.

In the POWER area, revised curriculum requirements for agricultural education majors lists Agricultural Mechanization and Systems 232, Small Air-Cooled Engines, in place of Agricultural Mechanization and Systems 230, Power for Agricultural Operations. In the small engines course, students utilize precision measuring tools, use and interpret the readings of ignition and other engine test equipment, and
<table>
<thead>
<tr>
<th>Competency category</th>
<th>Individual competencies in each category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arc Welding - Table 26</td>
<td>Explain the meaning of welder nameplate information</td>
</tr>
<tr>
<td></td>
<td>Identify electrodes by a color code and/or an A.W.S. classification number</td>
</tr>
<tr>
<td></td>
<td>Strike and run beads with a D.C. welder</td>
</tr>
<tr>
<td></td>
<td>Weld vertically with the metal in a vertical plane</td>
</tr>
<tr>
<td>Oxy-acetylene Welding - Table 27</td>
<td>Bronze-weld steel</td>
</tr>
<tr>
<td>Painting - Table 29</td>
<td>Select the type of paint for a given application</td>
</tr>
<tr>
<td></td>
<td>Select, use, and clean a paint spray gun</td>
</tr>
<tr>
<td></td>
<td>Select and apply wood preservatives</td>
</tr>
<tr>
<td></td>
<td>Select and apply paint to metal surfaces</td>
</tr>
<tr>
<td>Safety - Table 30•</td>
<td>Describe safety procedures to be used with electrical tools, equipment, and devices</td>
</tr>
<tr>
<td></td>
<td>List methods to prevent the build-up of carbon monoxide and other fumes</td>
</tr>
</tbody>
</table>

*Table numbers indicate source of more complete information about competency categories.
**TABLE 33.--Competencies in the CONHAINT subject matter area requiring some to much preparation by at least 50 percent of the teachers and taught or used by at least 50 percent of the teachers**

<table>
<thead>
<tr>
<th>Competency category</th>
<th>Individual competencies in each category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shop and Shop Facilities - Table 17*</td>
<td>Plan a high school agricultural mechanics shop</td>
</tr>
<tr>
<td></td>
<td>Develop a list of desirable tools for various types of shops</td>
</tr>
<tr>
<td></td>
<td>Select, specify, and order tools, equipment, supplies, and materials</td>
</tr>
<tr>
<td></td>
<td>Maintain school shop discipline</td>
</tr>
<tr>
<td>Project Planning - Table 18</td>
<td>Make a cutting list and a bill of materials</td>
</tr>
<tr>
<td>Hand Tools - Table 19</td>
<td>Select and use precision measuring tools (micrometers)</td>
</tr>
<tr>
<td>Concrete and Masonry - Table 22</td>
<td>Estimate the quantity of concrete and materials needed</td>
</tr>
<tr>
<td></td>
<td>Place and finish concrete</td>
</tr>
<tr>
<td></td>
<td>Cure concrete</td>
</tr>
<tr>
<td>Woodworking and Construction - Table 23</td>
<td>Select lumber by classification and grade</td>
</tr>
<tr>
<td></td>
<td>Describe the characteristics and grades of plywood</td>
</tr>
<tr>
<td></td>
<td>Identify building construction members by name</td>
</tr>
<tr>
<td></td>
<td>Lay out and cut rafters</td>
</tr>
<tr>
<td></td>
<td>Select and apply roofing materials</td>
</tr>
<tr>
<td>Cold and Hot Metal Working - Table 24</td>
<td>Identify metals by a spark or other type of test</td>
</tr>
<tr>
<td></td>
<td>Specify and order standard steel shapes by name and dimension</td>
</tr>
<tr>
<td></td>
<td>Select and use files</td>
</tr>
<tr>
<td></td>
<td>Select and use twist drills</td>
</tr>
<tr>
<td></td>
<td>Select and use standard threaded fasteners</td>
</tr>
<tr>
<td>Soldering and Sheet Metal - Table 25</td>
<td>Select the solder and flux for a given application</td>
</tr>
<tr>
<td></td>
<td>Solder using a propane torch</td>
</tr>
<tr>
<td></td>
<td>Solder galvanized metal</td>
</tr>
<tr>
<td></td>
<td>Use rivets and riveting tools to join sheet metal</td>
</tr>
<tr>
<td>Competency category</td>
<td>Individual competencies in each category</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hitches and Hitching - Table 14</td>
<td>Describe how a change in hitch position affects weight transfer and tractor stability</td>
</tr>
<tr>
<td></td>
<td>Define center of pull and center of draft</td>
</tr>
<tr>
<td>Selection and Economics - Table 15</td>
<td>Determine tractor operating costs of depreciation, interest, taxes, housing, insurance, fuel, lubricants,</td>
</tr>
<tr>
<td></td>
<td>maintenance, and repair</td>
</tr>
<tr>
<td>Troubleshooting - Table 16</td>
<td>Determine the cause and correct the failure of an engine to crank and/or start</td>
</tr>
<tr>
<td></td>
<td>Determine the cause and correct the failure of an engine to run properly or develop horsepower</td>
</tr>
<tr>
<td>Safety - Table 16</td>
<td>Discuss the safe handling and storage of fuels and lubricants</td>
</tr>
</tbody>
</table>

*Table numbers indicate source of more complete information about competency categories.
<table>
<thead>
<tr>
<th>Competency category</th>
<th>Individual competencies in each category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Governing Systems - Table 9</td>
<td>Describe the general operation and function of an engine governing system</td>
</tr>
<tr>
<td>Gasoline Fuel Systems - Table 10</td>
<td>Explain the air/fuel ratio requirements of an engine for starting, idling, part-load, and full-load operation&lt;br&gt;Explain the operation of the float, choke, idling, and load system of a carburetor&lt;br&gt;Adjust the idle mixture, load mixture, and idle speed screw on a carburetor&lt;br&gt;Remove and replace a carburetor and/or fuel pump</td>
</tr>
<tr>
<td>Diesel Fuel Systems - Table 10</td>
<td>List and describe the functions of the various diesel fuel system components&lt;br&gt;Change diesel fuel filters</td>
</tr>
<tr>
<td>Electrical Starting Systems - Table 11</td>
<td>Describe the effects of low temperature on battery capacity and engine cranking power requirements&lt;br&gt;List and describe the functions of various starting system components</td>
</tr>
<tr>
<td>Ignition Systems - Table 12</td>
<td>Explain the effect of engine speed and load on optimum spark timing requirements</td>
</tr>
<tr>
<td>Charging Systems - Table 12</td>
<td>List and explain the functions of the various charging system components&lt;br&gt;Determine whether a charging system fault lies with the generator (alternator) or the regulator</td>
</tr>
<tr>
<td>Clutches - Table 13</td>
<td>Adjust tractor drive clutch free travel</td>
</tr>
<tr>
<td>Competency category</td>
<td>Individual competencies in each category</td>
</tr>
<tr>
<td>---------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Engine Fundamentals - Table 5*</td>
<td>Calculate displacement and compression ratio given the necessary factors</td>
</tr>
<tr>
<td></td>
<td>Define energy, inertia, force, torque, work, power, and horsepower</td>
</tr>
<tr>
<td></td>
<td>Define indicated, friction, flywheel, brake, belt, drawbar, PTO, and rated horsepower</td>
</tr>
<tr>
<td>Classification and Engine Basics - Table 6</td>
<td>Identify engine types by classification of fuel used, valve arrangement, cylinder arrangement, method of cooling, and displacement</td>
</tr>
<tr>
<td></td>
<td>Use and interpret the readings of a compression gauge</td>
</tr>
<tr>
<td></td>
<td>Determine rod and main crankshaft bearing wear</td>
</tr>
<tr>
<td>Intake and Exhaust Systems - Table 7</td>
<td>List and explain the functions of the intake and exhaust system components</td>
</tr>
<tr>
<td></td>
<td>Explain the importance and function of various types of air cleaners</td>
</tr>
<tr>
<td>Lubrication Systems - Table 8</td>
<td>List and explain the meaning of A.P.I. oil service classifications</td>
</tr>
<tr>
<td></td>
<td>Describe the meaning of oil viscosity index</td>
</tr>
<tr>
<td></td>
<td>Select an appropriate oil to be used in a tractor engine given the operating and weather conditions</td>
</tr>
<tr>
<td></td>
<td>Describe the operation and maintenance of the crankcase ventilation system</td>
</tr>
<tr>
<td></td>
<td>Describe the effects of engine operating temperature on wear rate, power output, and fuel consumption</td>
</tr>
<tr>
<td>Cooling Systems - Table 9</td>
<td>List the major causes of engine overheating and explain how each might be corrected</td>
</tr>
</tbody>
</table>
Install soft copper pipe (15%)
Remove and replace a diesel fuel injection nozzle (12%)
Calculate displacement and compression ratio given the necessary factors (9%)

The preceding list of competencies taught by a relatively low percentage of teachers may bear further investigation. Teachers may lack the ability or may not feel a need to teach the competency, an aspect not determined by this study.

Individual competencies

As far as individual competencies are concerned, it is recommended, as a conservative, arbitrary beginning, that those competencies that required some to much study and assistance by 50 percent or more of the teachers and that were taught by 50 percent or more teachers could be added to expanded or additional pre-service courses. Thirty-three competencies in the POWER area, shown in Table 32, and 34 competencies in the CONMAINT area, shown in Table 33, meet the above criteria.

In the POWER subject matter area it is recommended that greater emphasis be placed on the general competency categories involving diesel engines, turbocharging, lubricant selection, charging systems, troubleshooting, and tractor safety. In the CONMAINT subject matter area, it is recommended that the general competency categories of masonry, soldering, sheet metal, and painting be added to expanded or additional pre-service courses. Teacher educators may want to consider supplementing the in-service agricultural mechanics instruction by utilizing in-service workshops to include some of the competency areas listed above.
When the list of competencies was analyzed, it was found that 50 percent or more of the teachers taught 193 of the 240 competencies. Only 18 competencies, listed below, were taught by 30 percent or fewer teachers.

**POWER area:**

List the various types and explain the operation of hydraulic pumps, valves, cylinders, motors, etc. (30%)

Use and interpret the readings of a radiator cap tester (30%)

**CONMAINT area:**

Remove obstructions from traps and drain lines (30%)

List the various methods of extending tractor tire life (27%)

Install rigid plastic pipe (27%)

List the precautions in operating a tractor equipped with a turbocharger (26%)

Weld steel castings (26%)

Maintain and repair valves and faucets (26%)

Select and use plumbing tools (26%)

Install flexible plastic pipe (26%)

Describe metal temperatures and characteristics by heat colors (26%)

Define and explain the importance of an engine's lugging ability (23%)

Calculate transmission input to output shaft ratios given the necessary factors (22%)

Correct and air- or water-logged water supply tank (18%)

Determine tractor horsepower rating using a portable PTO dynamometer (15%)
Identify causes of paint failure (52%)
Select and use an electric soldering gun (52%)
Apply hard surfacing material using an oxy-acetylene torch (50%)
Weld sheet metal with an arc welder (50%)
Weld steel castings with an arc welder (50%)

Two competencies each in the categories of governing, cooling, and air intake were acquired by a relatively high percentage of the teachers on the job. Shop and shop facility areas were mentioned four times by a relatively high percentage of teachers as competencies acquired on the job. Competencies acquired on the job by such high percentages of teachers should be examined for greater emphasis or inclusion in pre-service courses.

Competencies taught or used

Finally, Table 31 shows that a combined average of nearly two-thirds (66 percent) of the teachers were teaching or using the selected POWER and CONMAINT agricultural mechanics competencies. However, more teachers (70 percent) were teaching CONMAINT competencies than were teaching POWER competencies. These teachers were relatively new, and, in some cases, the schools may not have provided adequate facilities and/or equipment to teach all of these competencies. The amount and type of agriculture in the community also might have tended to influence teachers to eliminate the teaching of certain competencies and to add others.
Determine whether a charging system fault lies with the generator (alternator) or regulator (58%)

Discuss the safe transportation of tractors and equipment on the highway by driving and by trucking (58%)

Set engine high idle rpm by adjusting the governor and/or the governor linkage on a specified engine (58%)

List the describe the functions of the various liquid cooling system components (52%)

Explain the importance and function of various types of air cleaners (50%)

Compare the two-stroke cycle engine with the four-stroke cycle engine in terms of power, weight, efficiency, and application (48%)

Describe the operation and purpose of a supercharger and turbocharger (48%)

Service a liquid cooling in preparation for cold weather operation (48%)

Remove and replace a governor (47%)

CONMAINT area:

Develop an inventory procedure for control of tools, equipment, supplies, and materials (67%)

Select and use a high pressure washer (65%)

Select and use thread chasers (63%)

Plan for storage and disposal of scrap and waste materials (61%)

Control the use and security of tools, equipment, supplies, and materials (60%)

Describe the shop requirements for safe eye protection (58%)

Select and apply paint to metal surfaces (56%)

Bend or shape sheet metal with pliers, seamers, or a vise and hammer (56%)

Select, specify and order tools, equipment, supplies, and materials (54%)
Estimate project costs (39%)
Read and interpret a drawing or plan (39%)
Square a board (38%)
Select the correct welding electrode for a given application (37%)
Strike and run beads with an A.C. welder (35%)
List safety practices to be used when welding (35%)
Select and use squares (35%)
Select and use hand hack saws (35%)
Select, use, clean, and store paint brushes (33%)
Select and use a radial arm saw (33%)

Competencies in POWER acquired in high school by the greatest percentage of teachers were those involving basic engine principles and maintenance. The competencies in CONMAINT learned in high school appear to have been basic shop skills that a student taking vocational agriculture or industrial arts might acquire.

On the job.—When needed competencies have not been acquired elsewhere, a teacher must, of necessity, learn them on the job. The following list of POWER and CONMAINT competencies represent those which the highest percentage of teachers reported acquiring on the job. The list is in descending order with the percentage of teachers shown after each competency.

**POWER area:**

Remove and replace a diesel fuel injection nozzle (60%)

Select a battery by type and capacity rating for a given application (60%)

Use and interpret the readings of a compression gauge (59%)
competencies that the highest percentage of teachers reported had been acquired in high school. The list is in descending order with the percentage of teachers shown after each competency.

**POWER area:**

- List and explain the four strokes of a four-stroke cycle engine (48%)
- List and explain the two strokes of a two-stroke cycle engine (41%)
- List the possible causes of excess engine oil consumption (37%)
- List and explain the functions of the various components of the gasoline fuel system (37%)
- Remove, clean, inspect, gap, and replace spark plugs (31%)
- Identify engine parts by name and function (30%)
- Test the specific gravity of a storage battery electrolyte with a hydrometer (27%)
- Remove and replace points and condenser (26%)
- List the precautions when jumping or charging batteries (24%)
- Define and explain how to minimize side draft (25%)
- Define center of pull and center of draft (24%)
- List and explain the functions of the various ignition systems components (22%)

**CONMAINT area:**

- Calculate board feet (74%)
- Identify common hand tools by name (54%)
- Select and use a bench or floor drill press (48%)
- Select and use vises and clamps (48%)
- Select and use a table saw (46%)
Select and install hinges, pulls, and other miscellaneous building hardware (64%)  
Construct forms for concrete (60%)  
Place and finish concrete (56%)  
Identify and select pipe fittings (56%)  
Reinforce concrete (54%)  
Maintain and repair valves and faucets (52%)  
Remove frozen nuts and bolts that have broken off (52%)  
Build roof trusses (50%)  
Select and use standard threaded fasteners (48%)  
Select the kind and size of pipe to use for a given application (48%)

The POWER competency list above appears to include many routine maintenance items that teachers may have encountered as a tractor operator. Competencies involving plumbing and concrete appear more frequently than other categories in the CONMAINT list. In general, the list of competencies acquired in work experience seem to be a pattern of skills that prospective teachers may have learned while working in a position involving production agriculture.

High school.--Many of the prospective teachers of vocational agriculture may have had an opportunity to take vocational agriculture in high school and to participate in the F. F. A. chapter. In doing so, they would have had an opportunity to be exposed to many of the competencies included in this study. The following list represents the
than college. The following lists were generated by selection of the competencies acquired by the highest percentage of respondents during work experience, in high school, and on the job, respectively.

**Work experience.**—The following list represents the competencies that the highest percentage of teachers reported were acquired during work experience, in descending order with percentage of teachers shown after each competency.

**POWER area:**

- Change the oil and oil filter of an engine (70%)
- Remove and install a storage battery (70%)
- Clean, visually inspect, and add water to a battery (52%)
- Change diesel fuel filters (46%)
- Explain the purpose and principle of operation of a swinging drawbar (46%)
- Bleed air from a diesel fuel system (45%)
- Discuss the safe operation of agricultural and industrial tractors (44%)
- Remove and replace a distributor (44%)
- Perform general maintenance on a hydraulic system (43%)
- Remove, clean, inspect, gap, and replace spark plugs (42%)
- Explain the meaning of tire dimensions (42%)
- Remove and replace a cylinder head and gasket (40%)

**CONMAINT area:**

- Remove obstructions from traps and drain lines (72%)
- Correct an air- or water-logged tank (71%)
- Install rigid plastic pipe (69%)
- Construct wall framing (64%)
Correct an air- or water-logged water supply tank (22%)
Plan a high school agricultural mechanics shop (22%)
Identify causes of paint failure (20%)

In the POWER area list of competencies above, competencies involving electrical testing, hydraulics, diesel fuel systems, and turbocharging are mentioned at least twice each. In the CONMAINT area, competencies involving soldering, plumbing, hard surfacing, and construction appear at least twice. The area of POWER would seem to require much preparation to teach or use by a greater number of teachers than would the CONMAINT area. While 30 to 59 percent of the teachers listed the above POWER competencies as requiring much preparation, only 20 to 30 percent reported the CONMAINT competencies as requiring much preparation.

Competency acquisition

Information presented in Table 31 shows a similarity between POWER and CONMAINT competencies with respect to where teachers had acquired them. In the combined averages, about a third of the teachers (34 percent) acquired competencies on the job, over one-fourth (29 percent) acquired competencies in college, and less than one-fourth (23 percent) acquired competencies during work experience. High school was not a major source of competency acquisition as an average of only 15 percent of the teachers had acquired competencies there.

It might be useful to teacher educators to examine competencies that a high percentage of teachers were acquiring from sources other
Calculate transmission input to output shaft ratios given the necessary factors (45%)

Explain the operation of basic hydraulic circuits (42%)

List the effects of adding a turbocharger to an engine not originally equipped with a turbocharger (39%)

List and describe the functions of the various diesel fuel system components (38%)

Use and interpret a coil and condenser tester (33%)

List and explain the basic principles of hydraulics (33%)

Describe the operation and purpose of a supercharger and turbocharger (33%)

Test a battery with a voltmeter at a high discharge rate (32%)

Remove and replace a governor (31%)

Bleed air from a diesel fuel system (31%)

Perform general maintenance on a hydraulic system (31%)

Determine whether a charging system fault lies with the generator (alternator) or regulator (30%)

**CONMAINT area:**

Install soft copper pipe (30%)

Apply hard surfacing material using an oxy-acetylene torch (27%)

Lay out a foundation (26%)

Identify building construction members by name (23%)

Solder galvanized metal (23%)

Hard surface materials using an arc welder (23%)

Solder copper (22%)

Select and use plumbing tools (22%)

Cut cast iron with an oxy-acetylene torch (22%)
TABLE 31.—Summary of teachers' competencies in POWER and CONMAINT subject matter areas with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency area</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Agricultural Engineering 230 (POWER)</td>
<td>44%</td>
<td>42%</td>
<td>14%</td>
</tr>
<tr>
<td>Agricultural Engineering 240 (CONMAINT)</td>
<td>55</td>
<td>35</td>
<td>10</td>
</tr>
<tr>
<td>POWER and CONMAINT combined</td>
<td>50</td>
<td>39</td>
<td>11</td>
</tr>
</tbody>
</table>
where they had acquired the competency, and whether or not they currently used or taught it.

**Competency preparation**

As information in Table 31 shows, an overall average of 44 percent of the teachers would require little preparation to teach or use competencies in the POWER subject matter area; 55 percent would require little preparation to teach or use competencies in the CONMAINT subject matter area. Teachers would require more preparation to teach or use POWER subject matter competencies, with 56 percent requiring from some to much preparation, compared to 45 percent who would require some to much preparation to teach or use CONMAINT subject matter competencies. With a combined average, nearly 50 percent of the teachers would require some to much preparation to teach the selected POWER and CONMAINT agricultural mechanics competencies.

Certain competencies appeared to require a much higher level of preparation than others. The following list represents competencies that were reported by the highest percentage of teachers as requiring much preparation to teach or use. Figures after each competency represent the percentage of teachers that would require much preparation to teach or use the competency.

**POWER area:**

List the various types and explain the operation of hydraulic pumps, valves, cylinders, motors, etc. (58%)

Determine an optimum implement width and tractor size and type given the necessary factors (52%)

Remove and replace a diesel fuel injection nozzle (48%)
assistance to teach or use competencies involving safety procedures with electrical tools, safety procedures with materials handling, and prevention of fume build-up. Teachers had acquired competencies in safety almost equally on the job and in college, as an average of 35 and 33 percent, respectively, responded. An average of 90 percent of the teachers taught or used safety competencies.

Safety is important to individuals and to teachers because of liability, yet an average of 35 percent of the teachers had acquired knowledge of safety practices on the job. A one credit hour safety course, previously mentioned, is available in the Department of Agricultural Engineering. It is recommended that all prospective teachers elect or be required to take the course.

Summary of Findings

Responses from a panel of experts to 480 agricultural mechanics competencies were weighted and the means used to rank the competencies from "strongly agree" to "strongly disagree" that the competency should be included in the required pre-service courses taught in the Agricultural Engineering Department. No competency received a mean that would place it under the "strongly disagree" heading, and only 7 percent of the competencies were in the "disagree" category. The great majority of the competencies were in the "agree" or "strongly agree" categories.

Each of two groups of young vocational agriculture teachers were asked to react to one-half of the 240 higher ranking competencies in the "strongly agree/agree" categories. Teachers were queried about the level of preparation they would need to teach or use each competency,
TABLE 30.--Teachers' competencies in safety with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Light</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>List methods to prevent the build-up of carbon</td>
<td>39%</td>
<td>46%</td>
<td>15%</td>
</tr>
<tr>
<td>monoxide and other fumes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Describe safety procedures to be used with electrical</td>
<td>50</td>
<td>42</td>
<td>08</td>
</tr>
<tr>
<td>tools, equipment, and devices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify procedures that might insure safety</td>
<td>55</td>
<td>41</td>
<td>04</td>
</tr>
<tr>
<td>in the handling of materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>List safety practices to be observed in the use of</td>
<td>63</td>
<td>26</td>
<td>11</td>
</tr>
<tr>
<td>power tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify first-aid procedures to use in case of an</td>
<td>63</td>
<td>30</td>
<td>07</td>
</tr>
<tr>
<td>accident</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>List safety rules and practices that might prevent</td>
<td>65</td>
<td>31</td>
<td>04</td>
</tr>
<tr>
<td>falls</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Describe how to prevent and extinguish fires</td>
<td>70</td>
<td>26</td>
<td>04</td>
</tr>
<tr>
<td>List the safety practices to be used when welding</td>
<td>73</td>
<td>27</td>
<td>00</td>
</tr>
<tr>
<td>List safety precautions in the use of hand tools</td>
<td>78</td>
<td>15</td>
<td>07</td>
</tr>
<tr>
<td>Identify safety practices in the handling of</td>
<td>78</td>
<td>15</td>
<td>07</td>
</tr>
<tr>
<td>welding gas cylinders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Describe the safe behavior of shop workers</td>
<td>81</td>
<td>15</td>
<td>04</td>
</tr>
<tr>
<td>Describe safe dress for shop work</td>
<td>82</td>
<td>11</td>
<td>07</td>
</tr>
<tr>
<td>Describe the requirements for eye protection</td>
<td>85</td>
<td>11</td>
<td>04</td>
</tr>
<tr>
<td>Mean</td>
<td>68</td>
<td>26</td>
<td>06</td>
</tr>
</tbody>
</table>
TABLE 29.--Teachers' competencies in painting with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Identify causes of paint failure</td>
<td>24%</td>
<td>56%</td>
<td>20%</td>
</tr>
<tr>
<td>Select the type of paint for a given application</td>
<td>35%</td>
<td>54%</td>
<td>11%</td>
</tr>
<tr>
<td>Select, use, and clean a paint spray gun</td>
<td>38%</td>
<td>54%</td>
<td>08%</td>
</tr>
<tr>
<td>Select and apply paint to metal surfaces</td>
<td>46%</td>
<td>42%</td>
<td>12%</td>
</tr>
<tr>
<td>Prepare paint by mixing, thinning, and straining</td>
<td>61%</td>
<td>31%</td>
<td>08%</td>
</tr>
<tr>
<td>Prepare surfaces to be painted</td>
<td>69%</td>
<td>27%</td>
<td>04%</td>
</tr>
<tr>
<td>Select, use, clean, and store paint brushes</td>
<td>82%</td>
<td>11%</td>
<td>07%</td>
</tr>
</tbody>
</table>

Mean: 50 40 10 31 17 08 44 72 28
acquisition during work experience, and competencies not taught
ranked as the highest average percentages for the entire study. In
apparent disagreement with the panel of experts as to the importance
of these competencies, an average of just over one-fourth (27 percent)
of the teachers taught or used water and plumbing system competencies.

Painting

On the average, 50 percent of the teachers required little prep­
}aration to teach painting competencies, as shown by data in Table 29.
More than 50 percent of the teachers indicated they would require some
preparation to teach paint selection, use of a spray gun, and identifi­
cation of causes of paint failure. Competencies were acquired on the
job or during work experience by an average of 44 and 31 percent of the
teachers, respectively. An average of 72 percent of the teachers taught
or used painting competencies. More than 60 percent of the teachers
taught all painting competencies with the exception of identification
of causes of paint failures which was taught by 33 percent.

With a high percentage of the teachers teaching or using paint­
ing competencies and over 40 percent acquiring the competencies on the
job, teachers could benefit from pre-service instruction or in-service
instruction in painting competencies.

Safety

As shown in Table 30, an average of 68 percent of the teachers
would require little preparation to teach or use safety competencies.
However, over 40 percent indicated they would require some study and
<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Water and Plumbing Systems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify and select pipe fittings</td>
<td>31%</td>
<td>58%</td>
<td>11%</td>
</tr>
<tr>
<td>Install soft copper pipe</td>
<td>26</td>
<td>44</td>
<td>30</td>
</tr>
<tr>
<td>Install flexible plastic pipe</td>
<td>30</td>
<td>55</td>
<td>15</td>
</tr>
<tr>
<td>Select the kind and size of pipe to use for a given application</td>
<td>20</td>
<td>64</td>
<td>16</td>
</tr>
<tr>
<td>Correct an air- or water-logged tank</td>
<td>33</td>
<td>45</td>
<td>22</td>
</tr>
<tr>
<td>Select and use plumbing tools</td>
<td>37</td>
<td>41</td>
<td>22</td>
</tr>
<tr>
<td>Maintain and repair valves and faucets</td>
<td>44</td>
<td>52</td>
<td>04</td>
</tr>
<tr>
<td>Remove obstructions from traps and drain lines</td>
<td>59</td>
<td>37</td>
<td>04</td>
</tr>
<tr>
<td>Install rigid plastic pipe</td>
<td>46</td>
<td>39</td>
<td>15</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td><strong>36</strong></td>
<td><strong>48</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>
cutting cast iron and applying hard surfacing were not taught by at least 50 percent of the teachers.

Teachers' college level preparation in this area seems to be adequate. Greater emphasis might be placed on the competencies of selection of welding equipment and supplies, cutting cast iron, and applying hard surfacing with an oxy-acetylene torch.

**Water and plumbing systems**

Teaching or using competencies in water and plumbing systems would require some preparation by an average of 48 percent of the teachers, as indicated by information in Table 28. This is the greatest amount of preparation required for any competency category in the study. In only three competencies within this area--installation of rigid plastic pipe, maintenance and repair of valves and faucets, and removal of obstructions from drains--would as many as 40 percent of the teachers have required little preparation to teach or use. Work experience was the main source of competency acquisition, according to an average of 56 percent of the teachers. In every competency within the water and plumbing systems category the highest percentage of teachers indicated work experience as the source of competency acquisition. However, only one of the competencies was taught by as many as 42 percent of the teachers. On the average, 27 percent of the teachers taught water and plumbing competencies.

The area of water and plumbing systems might bear additional investigation as the averages are unique when compared to any other competency categories in the study. The preparation level, the
TABLE 27. -- Teachers' competencies in oxy-acetylene welding with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Oxy-Acetylene Welding:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apply hard surfacing</td>
<td>27%</td>
<td>46%</td>
<td>27%</td>
</tr>
<tr>
<td>Cut cast iron</td>
<td>30</td>
<td>48</td>
<td>22</td>
</tr>
<tr>
<td>Bronze-weld steel</td>
<td>50</td>
<td>38</td>
<td>12</td>
</tr>
<tr>
<td>Bronze-weld cast iron</td>
<td>52</td>
<td>41</td>
<td>07</td>
</tr>
<tr>
<td>Select welding equipment and supplies</td>
<td>54</td>
<td>38</td>
<td>08</td>
</tr>
<tr>
<td>Select proper tip size and operating pressures for an</td>
<td>54</td>
<td>46</td>
<td>00</td>
</tr>
<tr>
<td>application</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain the principles of fusion and adhesion welding</td>
<td>59</td>
<td>30</td>
<td>11</td>
</tr>
<tr>
<td>Fusion weld without filler rod</td>
<td>70</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>Fusion weld with filler rod</td>
<td>70</td>
<td>26</td>
<td>04</td>
</tr>
<tr>
<td>Install regulators, hoses, and tip. Open tanks, set</td>
<td>81</td>
<td>19</td>
<td>00</td>
</tr>
<tr>
<td>pressures, and check for leaks. Light, adjust, and turn</td>
<td>85</td>
<td>08</td>
<td>07</td>
</tr>
<tr>
<td>off flame</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cut or pierce steel with torch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEAN</td>
<td>57</td>
<td>33</td>
<td>10</td>
</tr>
</tbody>
</table>
An average of three-fourths of the teachers taught or used arc welding competencies. Over 50 percent of the teachers taught all but four of the competencies in arc welding. Those four competencies were using a D.C. welder, welding steel castings, welding sheet metal, and hard surfacing materials.

It appears that college level instruction in the area of arc welding was adequate for the most part. More emphasis could be placed on the competencies of welder nameplate information; identification of electrodes; selection, installation and maintenance of welders; welding horizontally on a vertical surface; welding vertically in a vertical plane; plugging holes; welding steel castings; and hard surfacing materials.

Oxy-acetylene welding

The results shown in Table 27 indicate that an average of 57 percent of the teachers required little preparation to teach oxy-acetylene welding. However, more than 41 percent of the teachers would require some preparation to teach or use four competencies—proper tip and pressure selection, bronze-weld cast iron, cut cast iron, and apply hard surfacing. Oxy-acetylene competencies were acquired in college by an average of 58 percent of the teachers. Only the competencies of selection of welding equipment and the application of hard surfacing were acquired on the job by a greater percentage of teachers than acquired the same competencies in college. An average of 69 percent of the teachers taught oxy-acetylene competencies. The competencies of
<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Plug holes</td>
<td>82%</td>
<td>11%</td>
<td>07%</td>
</tr>
<tr>
<td>Identify weld quality in terms of the four welding fundamentals</td>
<td>85</td>
<td>04</td>
<td>11</td>
</tr>
<tr>
<td>MEAN</td>
<td>59</td>
<td>32</td>
<td>09</td>
</tr>
</tbody>
</table>
TABLE 26.—Teachers' competencies in arc welding with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Arc Welding:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify electrodes by a color code and/or and A.W.S. classification number</td>
<td>23%</td>
<td>65%</td>
<td>12%</td>
</tr>
<tr>
<td>Hard surface materials</td>
<td>31</td>
<td>46</td>
<td>23</td>
</tr>
<tr>
<td>Weld steel castings</td>
<td>41</td>
<td>44</td>
<td>15</td>
</tr>
<tr>
<td>Strike and run beads with a D.C. welder</td>
<td>42</td>
<td>39</td>
<td>19</td>
</tr>
<tr>
<td>Weld sheet metal</td>
<td>42</td>
<td>39</td>
<td>19</td>
</tr>
<tr>
<td>Explain the meaning of welder nameplate information</td>
<td>45</td>
<td>48</td>
<td>07</td>
</tr>
<tr>
<td>Weld vertically with metal in a vertical plane</td>
<td>48</td>
<td>48</td>
<td>04</td>
</tr>
<tr>
<td>Weld horizontally with the metal in a vertical plane</td>
<td>52</td>
<td>37</td>
<td>11</td>
</tr>
<tr>
<td>Select, install, and maintain an arc welder</td>
<td>54</td>
<td>35</td>
<td>11</td>
</tr>
<tr>
<td>Control distortion, warping, and cracking</td>
<td>55</td>
<td>41</td>
<td>04</td>
</tr>
<tr>
<td>Select initial welder heat settings</td>
<td>58</td>
<td>34</td>
<td>08</td>
</tr>
<tr>
<td>Weld cast iron</td>
<td>59</td>
<td>30</td>
<td>11</td>
</tr>
<tr>
<td>Explain how an arc welder operates</td>
<td>65</td>
<td>31</td>
<td>04</td>
</tr>
<tr>
<td>Make butt, lap, and tee welds</td>
<td>65</td>
<td>35</td>
<td>00</td>
</tr>
<tr>
<td>List the four fundamentals of welding that control heat</td>
<td>69</td>
<td>23</td>
<td>08</td>
</tr>
<tr>
<td>Strike and run beads with an A.C. welder</td>
<td>69</td>
<td>27</td>
<td>04</td>
</tr>
<tr>
<td>Select arc welding equipment, tools, and supplies</td>
<td>70</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>Make multiple pass welds</td>
<td>74</td>
<td>19</td>
<td>07</td>
</tr>
<tr>
<td>Cut and pierce metal with an arc welder</td>
<td>77</td>
<td>19</td>
<td>04</td>
</tr>
<tr>
<td>Select the correct welding electrode for an application</td>
<td>82</td>
<td>11</td>
<td>07</td>
</tr>
</tbody>
</table>
the teachers taught or used the competencies. Soldering copper and
the use of self-tapping screws were taught by only 37 and 31 percent
of the teachers, respectively.

At the time of this study, soldering and sheet metal competencies were not being taught to teachers in pre-service education. In view of the number of teachers who were teaching the competencies and the level of difficulty experienced, it is recommended that this area be added to teachers' college level instruction.

Arc welding

From Table 26 it can be determined that an average of 59 percent
of the teachers required little preparation to teach or use arc welding
competencies. In only four competencies—meaning of welder nameplate
information, identification of electrodes, welding steel castings, and
hard surfacing materials—would more than 44 percent of the teachers
require some preparation to teach or use.

Competencies in arc welding were acquired primarily in college,
as reported by an average of 44 percent of the teachers. An unusually
high percentage of the teachers (81 percent) reported that they had
acquired the competency of identifying weld quality in terms of the
four fundamentals in college. However, in seven of the competencies—
install an arc welder, maintain an arc welder, weld horizontally on a
vertical surface, weld vertically with metal in a vertical plane, plug
holes, weld steel castings, and hard surface metal—41 percent or more
of the teachers had acquired the competency on the job.
<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Soldering and Sheet Metal Working:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solder using a propane torch</td>
<td>35%</td>
<td>46%</td>
<td>19%</td>
</tr>
<tr>
<td>Solder galvanized metal</td>
<td>42%</td>
<td>35%</td>
<td>23%</td>
</tr>
<tr>
<td>Solder copper</td>
<td>45%</td>
<td>33%</td>
<td>22%</td>
</tr>
<tr>
<td>Select the solder and flux for a given application</td>
<td>48%</td>
<td>45%</td>
<td>07%</td>
</tr>
<tr>
<td>Use rivets and riveting tools to join sheet metal</td>
<td>50%</td>
<td>38%</td>
<td>12%</td>
</tr>
<tr>
<td>Select and use self-tapping screws to join sheet metal</td>
<td>54%</td>
<td>38%</td>
<td>08%</td>
</tr>
<tr>
<td>Bend or shape sheet metal with pliers, seamers or vise and hammer</td>
<td>59%</td>
<td>33%</td>
<td>08%</td>
</tr>
<tr>
<td>Cut sheet metal by hand with tin snips, bench shears, or chisels</td>
<td>69%</td>
<td>27%</td>
<td>04%</td>
</tr>
<tr>
<td>Select and use an electric soldering gun</td>
<td>74%</td>
<td>19%</td>
<td>07%</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>53%</td>
<td>35%</td>
<td>12%</td>
</tr>
</tbody>
</table>
require some preparation to teach or use the competency involving the bending, twisting, and shaping of cold metal. Competencies in this category were acquired on the job, in college, and during work experience by an average of 33, 30, and 24 percent of the teachers, respectively. An average of two-thirds of the teachers taught or used cold and hot metal working. All competencies were taught by more than half of the teachers except for shaping cold metal and the use of heat colors of metals.

Since teachers were teaching most of these competencies and were acquiring many of them on the job, more college level instruction in COMMAINT would appear to be beneficial. Specifically, identification of metals and description of metal characteristics by heat colors appeared to have been acquired in college, but teachers would have some difficulty in teaching or using these competencies.

Soldering and sheet metal working

An average of 53 percent of the teachers required little preparation to teach or use soldering and sheet metal working competencies, according to information in Table 25. Selecting solder and flux and using a propane torch would require some preparation, over 40 percent of the teachers indicated. An average of 40 percent of the teachers had acquired this category of competencies on the job; an average of 30 percent had acquired the competencies during work experience. Fifty-nine percent indicated college as the source for competency in the selection of solder and flux compared to 16 percent naming the same source for the next highest competency. On the average, 56 percent of
<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Cold and Hot Metal Working:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify metals by a spark or other type of test</td>
<td>27%</td>
<td>54%</td>
<td>19%</td>
</tr>
<tr>
<td>Describe metal temperature and characteristics by heat colors</td>
<td>33</td>
<td>52</td>
<td>15</td>
</tr>
<tr>
<td>Bend, twist, or shape cold metal</td>
<td>37</td>
<td>63</td>
<td>00</td>
</tr>
<tr>
<td>Specify and order standard steel shapes by name and dimension</td>
<td>44</td>
<td>45</td>
<td>11</td>
</tr>
<tr>
<td>Select and use twist drills</td>
<td>46</td>
<td>46</td>
<td>08</td>
</tr>
<tr>
<td>Select and use files</td>
<td>48</td>
<td>37</td>
<td>15</td>
</tr>
<tr>
<td>Select and use standard threaded fasteners</td>
<td>50</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>Remove frozen nuts and remove bolts that have broken off</td>
<td>52</td>
<td>40</td>
<td>08</td>
</tr>
<tr>
<td>Select and use punches and cold chisels</td>
<td>61</td>
<td>35</td>
<td>04</td>
</tr>
<tr>
<td>Select and use taps and dies</td>
<td>65</td>
<td>31</td>
<td>04</td>
</tr>
<tr>
<td>Select and use thread chasers</td>
<td>66</td>
<td>30</td>
<td>04</td>
</tr>
<tr>
<td>Select and use hand hack saws</td>
<td>69</td>
<td>27</td>
<td>04</td>
</tr>
<tr>
<td>Select and use bolt cutters</td>
<td>78</td>
<td>15</td>
<td>07</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>52</td>
<td>39</td>
<td>09</td>
</tr>
</tbody>
</table>
the teachers would require some preparation to teach or use specific competencies dealing with lumber classification and grade, characteristics of plywood, and rafter cutting. Most competencies were acquired in college, as an average of 34 percent of the teachers responded. Work experience was mentioned as a source of competency acquisition by an average of 28 percent of the teachers. An average of 66 percent of the teachers taught competencies in woodworking and construction. However, less than 50 percent of the teachers taught laying out a foundation, construction of wall framing, and building roof trusses.

Two competencies—selection of lumber by classification and grade and laying out and cutting rafters—were acquired in college by 60 percent or more of the teachers and were taught by at least 67 percent. However, 67 percent of the teachers would require some to much study and assistance to teach selection of lumber and 81 percent would require some to much study to teach rafter cutting.

More emphasis or different methods should be used in the CONMAINT course concerning these two particular competencies. Additional instruction in foundation layout, wall framing, and roof trusses would be desirable.

**Cold and hot metal working**

An average of 52 percent of the teachers would require little preparation to teach or use cold and hot metal working, as data in Table 24 show. Fifty percent or more of the teachers would require some study and assistance to teach identification of metals, shaping cold metal, and using heat colors of metal. Sixty-three percent would
TABLE 23.—Teachers' competencies in woodworking and construction with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent \((N = 27)\)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Lay out and cut rafters</td>
<td>19%</td>
<td>70%</td>
<td>11%</td>
</tr>
<tr>
<td>Lay out a foundation</td>
<td>30</td>
<td>44</td>
<td>26</td>
</tr>
<tr>
<td>Select lumber by classification and grade</td>
<td>33</td>
<td>59</td>
<td>08</td>
</tr>
<tr>
<td>Describe the characteristics and grades of plywood</td>
<td>34</td>
<td>58</td>
<td>08</td>
</tr>
<tr>
<td>Identify building construction members by name</td>
<td>38</td>
<td>39</td>
<td>23</td>
</tr>
<tr>
<td>Build roof trusses</td>
<td>38</td>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>Construct wall framing</td>
<td>48</td>
<td>36</td>
<td>16</td>
</tr>
<tr>
<td>Select and apply roofing materials</td>
<td>48</td>
<td>41</td>
<td>11</td>
</tr>
<tr>
<td>Select the best method of fastening or joining wooden members</td>
<td>52</td>
<td>41</td>
<td>07</td>
</tr>
<tr>
<td>Select and install hinges, pulls, and other miscellaneous building hardware</td>
<td>54</td>
<td>38</td>
<td>08</td>
</tr>
<tr>
<td>Select and use various kinds of nails</td>
<td>55</td>
<td>41</td>
<td>04</td>
</tr>
<tr>
<td>Apply plywood or other building boards</td>
<td>56</td>
<td>26</td>
<td>18</td>
</tr>
<tr>
<td>Select and use glue and other adhesives to join wooden members</td>
<td>56</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td>Select and use bolts to fasten wood</td>
<td>58</td>
<td>38</td>
<td>04</td>
</tr>
<tr>
<td>Square a board</td>
<td>69</td>
<td>27</td>
<td>04</td>
</tr>
<tr>
<td>Select and use common wood and lag screws to fasten wood</td>
<td>70</td>
<td>30</td>
<td>00</td>
</tr>
<tr>
<td>Calculate board feet</td>
<td>82</td>
<td>11</td>
<td>07</td>
</tr>
</tbody>
</table>

**MEAN** 49  40  11  28  17  34  21  66  34
TABLE 22.—Teachers' competencies in concrete and masonry with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Concrete and Masonry:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Place and finish concrete</td>
<td>30%</td>
<td>55%</td>
<td>15%</td>
</tr>
<tr>
<td>Cure concrete</td>
<td>42</td>
<td>46</td>
<td>12</td>
</tr>
<tr>
<td>Estimate the quantity of concrete and materials</td>
<td>50</td>
<td>46</td>
<td>04</td>
</tr>
<tr>
<td>needed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimate the number and type of concrete blocks</td>
<td>54</td>
<td>27</td>
<td>19</td>
</tr>
<tr>
<td>needed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reinforce concrete</td>
<td>54</td>
<td>38</td>
<td>08</td>
</tr>
<tr>
<td>Construct forms for concrete</td>
<td>60</td>
<td>32</td>
<td>08</td>
</tr>
<tr>
<td></td>
<td>MEAN</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
27 percent acquired them on the job, more instruction in tool fitting competencies is needed in the pre-service CONMAINT course. The competencies of sharpening punches and chisels and replacement of tool handles should receive particular emphasis as over 40 percent of the teachers acquired them on the job.

Concrete and masonry

An average of 48 percent of the teachers, as can be seen in Table 22, required little preparation to teach or use concrete and masonry competencies. Work experience was the primary source of competency acquisition in this category, according to an average of 46 percent of the respondents. An average of 32 percent indicated that the concrete and masonry competencies were primarily acquired on the job. Teachers seemed to be weak in teaching the competency of placing and finishing concrete when compared to other concrete and masonry competencies.

The subject matter of concrete and masonry was not included in pre-service instruction, yet an average of 70 percent of the teachers taught the competencies. The general subject matter should be included in an expanded or added pre-service course or might be considered as an in-service course.

Woodworking and construction

An average of nearly half (49 percent) of the teachers required little preparation to teach or use competencies involving woodworking and construction, according to data in Table 23. More than half of
<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Select a grinding wheel for tool sharpening</td>
<td>54%</td>
<td>38%</td>
<td>08%</td>
</tr>
<tr>
<td>Sharpen and reshape punches and chisels</td>
<td>61%</td>
<td>35%</td>
<td>04%</td>
</tr>
<tr>
<td>Sharpen twist drills</td>
<td>63%</td>
<td>33%</td>
<td>04%</td>
</tr>
<tr>
<td>Replace handles in tools</td>
<td>71%</td>
<td>22%</td>
<td>07%</td>
</tr>
<tr>
<td>Reshape a screwdriver blade</td>
<td>73%</td>
<td>23%</td>
<td>04%</td>
</tr>
<tr>
<td>Dress and true a grinding wheel</td>
<td>78%</td>
<td>18%</td>
<td>04%</td>
</tr>
<tr>
<td>Clean and preserve tools</td>
<td>81%</td>
<td>04%</td>
<td>15%</td>
</tr>
<tr>
<td>MEAN</td>
<td>69%</td>
<td>25%</td>
<td>06%</td>
</tr>
</tbody>
</table>

TABLE 21.--Teachers' competencies in tool fitting with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)
Stationary power tools

An average of 62 percent of the teachers required little preparation to teach or use stationary power tool competencies, as found in Table 20. However, 44 percent indicated that they would require some study and assistance to teach selection and use of a power hack saw. This category of competencies was acquired primarily on the job, in high school or in college by an average of 31, 31, and 26 percent, respectively. An average of four-fifths (80 percent) of the teachers taught or used stationary power tool competencies. With the high percentage of teachers teaching the competencies and the variety of sources they had depended upon to acquire them, it would seem advisable to include more instruction in the area of selection and use of stationary power tools in the pre-service CONMAINT course.

Tool fitting

In Table 21 it is shown that an average of 69 percent of the teachers required little preparation to teach tool fitting competencies. Competencies were acquired primarily in college, as an average of 33 percent of the teachers responded. An average of 20 percent or more of the teachers acquired tool fitting in each of the other sources of work experience, high school or on the job. A large percentage (over 75 percent) of the teachers taught all of the competencies with an average of 84 percent of the teachers teaching the category of tool fitting.

Since a high percentage of the teachers taught all of the competencies, 25 percent required some preparation to teach them, and
<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Portable Power Tools:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select and use a high pressure washer</td>
<td>56%</td>
<td>28%</td>
<td>16%</td>
</tr>
<tr>
<td>Select and use a portable sabre saw</td>
<td>65%</td>
<td>35%</td>
<td>0%</td>
</tr>
<tr>
<td>Select and use a portable circular saw</td>
<td>81%</td>
<td>15%</td>
<td>04%</td>
</tr>
<tr>
<td>Select and use a portable electric drill</td>
<td>85%</td>
<td>04%</td>
<td>11%</td>
</tr>
<tr>
<td>MEAN</td>
<td>72%</td>
<td>20%</td>
<td>08%</td>
</tr>
<tr>
<td>Stationary Power Tools:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select and use a power hack saw</td>
<td>52%</td>
<td>44%</td>
<td>04%</td>
</tr>
<tr>
<td>Select and use a planer</td>
<td>56%</td>
<td>33%</td>
<td>11%</td>
</tr>
<tr>
<td>Select and use a table saw</td>
<td>61%</td>
<td>35%</td>
<td>04%</td>
</tr>
<tr>
<td>Select and use a radial arm saw</td>
<td>67%</td>
<td>22%</td>
<td>11%</td>
</tr>
<tr>
<td>Select and use a bench or pedestal grinder</td>
<td>67%</td>
<td>33%</td>
<td>00%</td>
</tr>
<tr>
<td>Select and use a bench or floor drill press</td>
<td>73%</td>
<td>23%</td>
<td>04%</td>
</tr>
<tr>
<td>MEAN</td>
<td>62%</td>
<td>32%</td>
<td>06%</td>
</tr>
</tbody>
</table>

TABLE 20.--Teachers' competencies in portable and stationary power tools with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)
to low. Competencies were taught or used by an average of 79 percent of the teachers. A relatively lower percentage of the teachers (56 percent) taught or used the selection and use of precision measuring tools.

Teachers need to be able to select and teach the use of precision measuring tools for metal work as well as checking engine specifications. It appears that the teachers were weak in this competency and needed more instruction in one of the pre-service courses or in-service workshops.

**Portable power tools**

Information in Table 20 shows that an average of 62 percent of the teachers required little preparation to teach or use portable power tool competencies. This category of competencies was acquired primarily on the job, as an average of 40 percent of the teachers indicated. Portable power tool competencies were taught or used by an average of 72 percent of the teachers.

Portable power tools, in most cases, are relatively inexpensive and easily adjusted. Since teachers reported that they would require little preparation to teach or use the competency, it might be appropriate that they acquire this category of competency on the job.
TABLE 19.—Teachers' competencies in hand tools with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Hand Tools:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select and use precision measuring tools</td>
<td>48%</td>
<td>37%</td>
<td>15%</td>
</tr>
<tr>
<td>(micrometers)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Select and use levels</td>
<td>52</td>
<td>37</td>
<td>11</td>
</tr>
<tr>
<td>Select and use wood layout tools</td>
<td>56</td>
<td>37</td>
<td>07</td>
</tr>
<tr>
<td>Select and use vises and clamps</td>
<td>58</td>
<td>34</td>
<td>08</td>
</tr>
<tr>
<td>Select and use bits and hand drills</td>
<td>67</td>
<td>26</td>
<td>07</td>
</tr>
<tr>
<td>Select and use hammers and sledges</td>
<td>67</td>
<td>29</td>
<td>04</td>
</tr>
<tr>
<td>Select and use squares</td>
<td>69</td>
<td>23</td>
<td>08</td>
</tr>
<tr>
<td>Identify common hand tools by name</td>
<td>73</td>
<td>19</td>
<td>08</td>
</tr>
<tr>
<td>Mean</td>
<td>61</td>
<td>30</td>
<td>09</td>
</tr>
</tbody>
</table>
TABLE 18.—Teachers' competencies in project planning with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Make a cutting list and a bill of materials</td>
<td>50%</td>
<td>38%</td>
<td>12%</td>
</tr>
<tr>
<td>Make a free-hand sketch utilizing the three principal views</td>
<td>52</td>
<td>33</td>
<td>15</td>
</tr>
<tr>
<td>Read or interpret a drawing or plan</td>
<td>54</td>
<td>35</td>
<td>11</td>
</tr>
<tr>
<td>Estimate project costs</td>
<td>54</td>
<td>35</td>
<td>11</td>
</tr>
<tr>
<td>Plan and develop a project work procedure</td>
<td>54</td>
<td>38</td>
<td>08</td>
</tr>
<tr>
<td>Select materials for project construction</td>
<td>54</td>
<td>38</td>
<td>08</td>
</tr>
<tr>
<td>Obtain project plans and select projects for students</td>
<td>63</td>
<td>30</td>
<td>07</td>
</tr>
<tr>
<td>Order materials using common units and designations</td>
<td>63</td>
<td>33</td>
<td>04</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>55</td>
<td>35</td>
<td>10</td>
</tr>
</tbody>
</table>
Project planning

An average of 55 percent of the teachers required little preparation to teach or use competencies in the area of project planning, as data in Table 18 show. An average of 40 percent of the teachers indicated college as the primary source of competency acquisition. A relatively large number (an average of 84 percent) of the teachers taught all of the competencies in this category.

In three competencies—obtain and select project plans, plan and develop project work, and order materials—40 percent or more of the teachers were acquiring the competency on the job. More emphasis might be placed on these competencies during the pre-service instruction in the CONMAINT course. Reading plans, drawing sketches, and making a cutting list and bill of materials were not taught by 23, 32, and 33 percent of the teachers, respectively. Perhaps these teachers were relying on standardized project plans that could be obtained and utilized with most of the planning, drawing, and a material list furnished with the plans.

Hand tools

As found in Table 19, an average of 61 percent of the teachers required little preparation to teach or use hand tool competencies. One competency, the selection and use of precision measuring tools, required some to much study and assistance for more than 50 percent of the teachers.

On the average, teachers acquired the competencies from all four sources almost equally with only a 7 percent difference from high
TABLE 17.--Teachers' competencies in shop and shop facilities with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent \( (N = 27) \)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lit.-</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Shop and Shop Facilities:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop a list of desirable tools for various types of shops</td>
<td>32%</td>
<td>56%</td>
<td>12%</td>
</tr>
<tr>
<td>Plan a high school agricultural mechanics shop</td>
<td>48%</td>
<td>30%</td>
<td>22%</td>
</tr>
<tr>
<td>Maintain school shop discipline</td>
<td>48%</td>
<td>45%</td>
<td>07%</td>
</tr>
<tr>
<td>Select, specify, and order tools, equipment, supplies, and materials</td>
<td>50%</td>
<td>42%</td>
<td>08%</td>
</tr>
<tr>
<td>Plan for storage and disposal of scrap and waste materials</td>
<td>52%</td>
<td>44%</td>
<td>04%</td>
</tr>
<tr>
<td>Develop an inventory procedure for control of tools, equipment, supplies, and materials</td>
<td>52%</td>
<td>44%</td>
<td>04%</td>
</tr>
<tr>
<td>Control the use and security of tools, equipment, supplies, and materials</td>
<td>56%</td>
<td>32%</td>
<td>12%</td>
</tr>
<tr>
<td>Plan storage of tools, equipment, supplies, and materials</td>
<td>59%</td>
<td>33%</td>
<td>08%</td>
</tr>
<tr>
<td>Select and utilize agricultural mechanics training aids and audio-visual materials</td>
<td>71%</td>
<td>22%</td>
<td>07%</td>
</tr>
<tr>
<td>MEAN</td>
<td>52%</td>
<td>39%</td>
<td>09%</td>
</tr>
</tbody>
</table>
Competencies in CONMAINT Subject Matter Area

Shop and shop facilities

As shown by data in Table 17, an average of 52 percent of the teachers required little preparation to teach or use competencies in the area of shop and shop facilities. Teachers were primarily acquiring shop and shop facility competencies on the job (an average of 43 percent) or in college (an average of 39 percent). A relatively high percentage of the teachers (60 percent or more) acquired school shop planning and storage planning in college. On the average, 70 percent of the teachers used the competencies in the shop and shop facilities category.

Forty-eight percent of the teachers did not utilize agricultural shop planning. This is understandable as they were relatively new teachers and probably had not had an occasion or felt the need to plan overall shop facilities. The same percentage of teachers did not utilize the competency of maintaining shop discipline. This may indicate the lack of a discipline problem in some schools.

It would seem that teachers might utilize more pre-service instruction in the CONMAINT course, particularly on the selection, ordering, inventory, and control of tools, equipment, and supplies as well as storage and disposal of waste or scrap materials since over 50 percent of the teachers were acquiring these competencies on the job.
competencies were acquired on the job by an average of 39 percent of the teachers while an average of 80 percent taught or used safety competencies.

While 88 to 96 percent of the teachers were teaching the first two safety competencies, the competency concerning the transportation of tractors and equipment on the highway was taught by only 56 percent. Since transportation on the highway is one of the most dangerous places for farm equipment operation, it would seem that the percentage should be much higher. Some teachers may have indicated that they did not teach this competency because of the phrase "by trucking" in the questionnaire item since many owners move tractors by driving them.

The area of safety should not only be included with other subject matter, but could be the main thrust of at least one or more preservice POWER classes. The Department of Agricultural Engineering offers a one credit hour course--Agricultural Mechanization and Systems 500, Farm and Home Safety--which could be scheduled by each student to help meet the needs for instruction in safety.
TABLE 16.—Teachers' competencies in troubleshooting and safety with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Troubleshooting:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determine the cause and correct the failure of an engine to run properly</td>
<td>28%</td>
<td>68%</td>
<td>04%</td>
</tr>
<tr>
<td>or develop horsepower</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determine the cause and correct the failure of an engine to crank and/or</td>
<td>41</td>
<td>55</td>
<td>04</td>
</tr>
<tr>
<td>start</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEAN</td>
<td>34</td>
<td>62</td>
<td>04</td>
</tr>
<tr>
<td>Safety:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discuss the safe handling and storage of fuels and lubricants</td>
<td>50%</td>
<td>50%</td>
<td>00%</td>
</tr>
<tr>
<td>Discuss the safe operation of agricultural and industrial tractors and</td>
<td>70</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discuss the safe transportation of tractors and equipment on the highway</td>
<td>70</td>
<td>22</td>
<td>08</td>
</tr>
<tr>
<td>by driving and by trucking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEAN</td>
<td>63</td>
<td>29</td>
<td>08</td>
</tr>
</tbody>
</table>
preparation to teach optimum implement and tractor size for a given agricultural operation, a competency acquired primarily in college or on the job. In view of the preparation requirements of teachers, it would seem that additional emphasis in the economics of tractor and implement selection is warranted in a pre-service expanded or additional course.

Nebraska Tractor Test

As data in Table 15 show, an average of 67 percent of the teachers required little preparation to obtain and interpret Nebraska Tractor Tests. They generally acquired the competency in college (59 percent), and a like number (59 percent) taught or used it. No additional emphasis or instruction in obtaining and interpreting Nebraska Tractor Tests appears necessary.

Troubleshooting

An average of 62 percent of the teachers would require some study and assistance to teach troubleshooting competencies, according to information in Table 16. The troubleshooting competencies were acquired on the job by an average of 35 percent of the teachers, however an average of 86 percent taught troubleshooting. The area of troubleshooting should be a major topic in the pre-service POWER course.

Safety

A comparatively high average of teachers (63 percent) would require little preparation to teach or use safety competencies dealing with agricultural tractors, as shown by data in Table 16. Safety
<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lit-tle</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td><strong>Selection and Economics:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determine an optimum implement width and tractor size and type given factors of acreage, crops, tillage practices, timeliness, etc.</td>
<td>18%</td>
<td>30%</td>
<td>52%</td>
</tr>
<tr>
<td>Determine tractor operating costs of depreciation, interest, taxes, housing, insurance, fuel, lubricants, maintenance, and repair</td>
<td>27</td>
<td>62</td>
<td>11</td>
</tr>
<tr>
<td>Compare the advantages and disadvantages of two-wheel drive, four-wheel drive, and crawler type tractors</td>
<td>31</td>
<td>65</td>
<td>04</td>
</tr>
<tr>
<td>List factors to be considered in the selection of tractor options such as engine, transmission, PTO, hitch, hydraulics, cab, etc.</td>
<td>34</td>
<td>58</td>
<td>08</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>27</td>
<td>54</td>
<td>19</td>
</tr>
<tr>
<td><strong>Nebraska Tractor Tests:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obtain and interpret Nebraska Tractor Test individual complete reports</td>
<td>67%</td>
<td>29%</td>
<td>04%</td>
</tr>
</tbody>
</table>
the teachers. While the category of hitches and hitching was seemingly not a problem for teachers, the competency dealing with side draft could be given greater emphasis in pre-service college courses.

Hydraulics

As found in Table 14, competencies in hydraulics would require some preparation for an average of 47 percent of the teachers to teach or use. An average of 25 percent would require little preparation. Competencies in hydraulics were acquired mostly on the job, as indicated by an average of 40 percent of the teachers. An average of 38 percent of the teachers taught or used this category of competencies. With a hydraulic system on virtually every tractor, it seems that competencies in this area are needed, and it would appear that they are not being acquired. Hydraulics competencies should be a part of an expanded or additional pre-service course.

Selection and economics

From Table 15 it can be determined that an average of 54 percent of the teachers would require some preparation to teach or use selection and economics competencies. This category of competencies was acquired in college by an average of 39 percent of the teachers while an average of 34 percent acquired the competencies on the job. An average of less than half (47 percent) of the teachers taught or used the competencies. The competency concerning determination of tractor operating costs appears somewhat unique in this category as it is acquired in college by 62 percent and taught by 70 percent of the teachers. Eighty-two percent of the teachers would require some to much
TABLE 14.—Teachers' competencies in hitching and hydraulic systems with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Hitches and Hitching:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Define and explain how to minimize side draft</td>
<td>26%</td>
<td>63%</td>
<td>11%</td>
</tr>
<tr>
<td>Explain the purpose and principle of operation of a swinging drawbar</td>
<td>58%</td>
<td>38%</td>
<td>04%</td>
</tr>
<tr>
<td>Define center of pull and center of draft</td>
<td>37%</td>
<td>56%</td>
<td>07%</td>
</tr>
<tr>
<td>Describe how a change in hitch position affects weight transfer and tractor stability</td>
<td>46%</td>
<td>54%</td>
<td>00%</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>42%</td>
<td>53%</td>
<td>05%</td>
</tr>
<tr>
<td>Hydraulic Systems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain the operation of basic hydraulic circuits</td>
<td>12%</td>
<td>46%</td>
<td>42%</td>
</tr>
<tr>
<td>Perform general maintenance on a hydraulic system</td>
<td>23%</td>
<td>46%</td>
<td>31%</td>
</tr>
<tr>
<td>List and explain the basic principles of hydraulics</td>
<td>30%</td>
<td>37%</td>
<td>33%</td>
</tr>
<tr>
<td>List the various types and explain the operation of hydraulic pumps, valves, cylinders, motors, etc.</td>
<td>34%</td>
<td>58%</td>
<td>08%</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>25%</td>
<td>47%</td>
<td>28%</td>
</tr>
</tbody>
</table>
Tires and traction

An average of 60 percent of the teachers responded that teaching competencies about tires and traction would require some preparation, as can be seen in Table 13. This category of competencies was acquired on the job by an average of 41 percent while 32 percent acquired the competencies in work experiences. Nearly two-thirds (64 percent) of the teachers were not teaching or using the competencies. While the area of tires and traction can be one of great importance, teachers, at least at the time of this study, either did not feel the need or lacked the preparation to teach it. In an expanded or revised pre-service course, the competency category of tires and traction should be included.

Hitches and hitching

According to information in Table 14, over 50 percent of the teachers would require some preparation to teach four of the five hitches and hitching competencies. Fifty-eight percent would require little preparation to teach or use the competency concerning a swinging drawbar. An average of 35 percent of the teachers acquired hitches and hitching competencies in college, and an average of 58 percent taught or used this category of competencies. Only the competency concerning side draft was taught or used by less than 50 percent of the teachers. The competency on weight transfer and tractor stability, closely allied with safety and clearly acquired in college, was taught by 81 percent of
<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Clutches:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjust tractor drive clutch free travel</td>
<td>48%</td>
<td>37%</td>
<td>15%</td>
</tr>
<tr>
<td>Transmissions:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calculate input to output shaft ratios given the necessary factors</td>
<td>33</td>
<td>22</td>
<td>45</td>
</tr>
<tr>
<td>Tires and Traction:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain traction changes as affected by dual wheels, inflation, weight on rear wheels, tire size, tire tread, traction conditions</td>
<td>31</td>
<td>58</td>
<td>11</td>
</tr>
<tr>
<td>Explain the meaning of tire dimensions</td>
<td>31</td>
<td>65</td>
<td>04</td>
</tr>
<tr>
<td>List the various methods of extending tire life</td>
<td>34</td>
<td>58</td>
<td>08</td>
</tr>
<tr>
<td>MEAN</td>
<td>32</td>
<td>60</td>
<td>08</td>
</tr>
</tbody>
</table>
Charging systems

Based on information in Table 12, an average of 41 percent of the teachers would require some preparation to teach or use the charging system competencies. What teachers knew about charging systems was learned on the job, as an average of 52 percent indicate. Yet, an average of 55 percent taught or used the competencies. Although charging system competencies were not included in the pre-service POWER course, the need for pre-service instruction in this area exists and should be included in an expanded or additional course.

Clutches

Nearly half (48 percent) of the teachers would require little preparation to teach clutch adjustment, as shown in Table 13. Forty-four percent of the teachers acquired the competency on the job and over half (52 percent) taught or used it. At least one lecture on tractor clutches would not be excessive and should be a part of an expanded or added pre-service course.

Transmissions

Forty-five percent of the teachers would require much preparation to teach or use the calculation of transmission shaft ratios, as shown in Table 13. Two-thirds (67 percent) acquired the competency in college, but less than one quarter (22 percent) taught or used it. The competency appears to have been taught but not in sufficient depth since teachers would require much study and assistance to teach or use it, and consequently probably do not.
TABLE 12.- Teachers' competencies in ignition and charging systems with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td><strong>Ignition Systems:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain the effect of engine speed and load on optimum spark timing</td>
<td>30%</td>
<td>59%</td>
<td>11%</td>
</tr>
<tr>
<td>requirements</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use and interpret the readings of a coil and condenser tester</td>
<td>37%</td>
<td>30%</td>
<td>33%</td>
</tr>
<tr>
<td>Use dwellmeter to set point gap</td>
<td>42%</td>
<td>31%</td>
<td>27%</td>
</tr>
<tr>
<td>List and explain the functions of the various ignition system components</td>
<td>52%</td>
<td>41%</td>
<td>07%</td>
</tr>
<tr>
<td>Time the distributor with a timing light</td>
<td>58%</td>
<td>27%</td>
<td>15%</td>
</tr>
<tr>
<td>Remove and replace a distributor</td>
<td>63%</td>
<td>30%</td>
<td>07%</td>
</tr>
<tr>
<td>Remove and replace points and condenser</td>
<td>70%</td>
<td>19%</td>
<td>11%</td>
</tr>
<tr>
<td>Remove, clean, inspect, gap, and replace spark plugs</td>
<td>85%</td>
<td>11%</td>
<td>04%</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>55%</td>
<td>31%</td>
<td>14%</td>
</tr>
<tr>
<td><strong>Charging Systems:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determine whether a charging system fault lies with the generator</td>
<td>26%</td>
<td>44%</td>
<td>30%</td>
</tr>
<tr>
<td>(alternator) or the regulator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>List and explain the functions of the various charging system components</td>
<td>35%</td>
<td>38%</td>
<td>27%</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>31%</td>
<td>41%</td>
<td>28%</td>
</tr>
</tbody>
</table>
Knowledge related to the engine electrical starting systems was not included in the subject matter area of Agricultural Engineering 230 (POWER) at the time of this study. Because of the percentages of teachers teaching competencies in this area and acquiring them during work experience or on the job, electrical starting systems should be included in an expanded or additional college level course.

**Ignition systems**

Data in Table 12 shows an average of 55 percent of the teachers would require little preparation to teach or use ignition system competencies. However, 59 percent would require some preparation to explain optimum spark requirements. More than 63 percent of the teachers would require some to much preparation to teach or use a dwellmeter and a coil and condenser tester. Thirty-three percent of the teachers acquired the competency on the job, with 28 and 26 percent acquiring the competency in work experience or in college, respectively. This general category of competencies was taught by an average of 69 percent of the teachers. The use of a dwellmeter and a coil and condenser tester was taught by less than 50 percent of the teachers.

With about one quarter (26 percent) of the teachers acquiring ignition system competencies in college, it is evident that they could benefit from additional pre-service education in this area. The use of electrical test equipment, particularly, stands out as an area of weakness.
TABLE 11.—Teachers' competencies in electrical starting systems with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td><strong>Electrical Starting Systems:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test the battery with a voltmeter at a high discharge rate</td>
<td>24%</td>
<td>44%</td>
<td>32%</td>
</tr>
<tr>
<td>Select a battery by type and capacity rating for a given application</td>
<td>30</td>
<td>63</td>
<td>07</td>
</tr>
<tr>
<td>List and describe the functions of various starting system components</td>
<td>30</td>
<td>63</td>
<td>07</td>
</tr>
<tr>
<td>Describe the effects of low temperature on battery capacity and engine cranking power requirements</td>
<td>44</td>
<td>45</td>
<td>11</td>
</tr>
<tr>
<td>Test the specific gravity of the electrolyte with a hydrometer</td>
<td>54</td>
<td>38</td>
<td>08</td>
</tr>
<tr>
<td>List the precautions when jumping or charging batteries</td>
<td>73</td>
<td>27</td>
<td>00</td>
</tr>
<tr>
<td>Clean, visually inspect, and add water to a storage battery</td>
<td>80</td>
<td>16</td>
<td>04</td>
</tr>
<tr>
<td>Remove and install a storage battery</td>
<td>85</td>
<td>08</td>
<td>07</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>52</td>
<td>38</td>
<td>10</td>
</tr>
</tbody>
</table>
preparation for teaching diesel fuel systems was required by five times as many teachers (26 percent) as for teaching gasoline fuel systems (5 percent). Nearly twice as many of the teachers (32 percent) acquired diesel fuel system competencies at work as for the gasoline fuel system (17 percent). Seventy-seven percent of the teachers taught or used competencies for gasoline fuel systems; only 48 percent used the diesel fuel system competencies.

In summary, teachers would experience some to much difficulty to teach or use diesel fuel system competencies, they acquired the competencies either in work experience or on the job, and less than half taught these competencies. With the predominance of new diesel tractors being sold today, it is apparent that preparation for teaching the area of diesel fuel systems is inadequate.

**Electrical starting systems**

Fifty-two percent of the teachers would require little preparation to teach or use electrical starting system competencies, according to the data in Table 11. Battery selection and starting system component functions would require some preparation for 63 percent of the teachers, however. Competencies in this category were acquired in work experience or on the job by an average of 36 and 35 percent of the teachers, respectively. Only the functions of various starting system components was acquired in college by as high as 41 percent of the respondents. Nearly two-thirds of the teachers taught five of the eight competencies. More than half of the teachers were not teaching battery selection or testing.
TABLE 10.—Teachers' competencies in gasoline and diesel fuel systems with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent \( (N = 27) \)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Gasoline Fuel Systems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain the operation of the float, choke, idling, and load system of a carburetor</td>
<td>19%</td>
<td>69%</td>
<td>12%</td>
</tr>
<tr>
<td>Explain the air/fuel ratio requirements of an engine for starting, idling, part-load, and full-load operation</td>
<td>27</td>
<td>69</td>
<td>04</td>
</tr>
<tr>
<td>Remove and replace a carburetor and/or fuel pump</td>
<td>50</td>
<td>46</td>
<td>04</td>
</tr>
<tr>
<td>Adjust the idle mixture, load mixture, and idle speed screw on a carburetor</td>
<td>50</td>
<td>50</td>
<td>00</td>
</tr>
<tr>
<td>List and describe the functions of the various components of the fuel system</td>
<td>59</td>
<td>37</td>
<td>04</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>41</td>
<td>54</td>
<td>05</td>
</tr>
<tr>
<td>Diesel Fuel Systems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remove and replace a diesel fuel injection nozzle</td>
<td>20%</td>
<td>32%</td>
<td>48%</td>
</tr>
<tr>
<td>List and describe the functions of the various diesel fuel system components</td>
<td>27</td>
<td>35</td>
<td>38</td>
</tr>
<tr>
<td>Bleed the air from a diesel fuel system</td>
<td>34</td>
<td>35</td>
<td>31</td>
</tr>
<tr>
<td>Change diesel fuel filters</td>
<td>50</td>
<td>42</td>
<td>08</td>
</tr>
<tr>
<td>Explain the importance of keeping diesel fuel clean</td>
<td>63</td>
<td>30</td>
<td>07</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>39</td>
<td>35</td>
<td>26</td>
</tr>
</tbody>
</table>
Gasoline fuel systems

Information in Table 10 shows gasoline fuel systems would require some preparation for an average of 54 percent of the teachers to teach or use. Gasoline fuel system competencies were acquired on the job by an average of 35 percent of the teachers and acquired in college by an average of 30 percent. Only the competency involving explanation of the air/fuel ratio was clearly acquired in college. An average of 77 percent of the teachers were teaching gasoline system competencies. No competency was taught by less than 65 percent of the teachers. With the high percentage of teachers teaching these competencies and the low percentage of teachers acquiring the competencies in college, it would seem more instruction in gasoline fuel systems would be desirable at the college level.

Diesel fuel systems

In Table 10, information indicates that an average of 61 percent of the teachers would require some to much preparation to teach diesel fuel systems. Competencies were acquired on the job by an average of 35 percent of the teachers and during work experience by 32 percent. Fewer than half of the teachers, an average of 48 percent, were teaching diesel competencies. While it is necessary to bleed a diesel fuel system after refueling a dry fuel tank, and an injector might be thought of as a more sophisticated equivalent of a spark plug in a gasoline engine, less than one-third of the teachers teach these competencies.

In comparison to gasoline fuel systems, the diesel fuel system area of competencies appears particularly weak. For example, much
An average of 39 percent of the teachers acquired the competencies on the job. In fact, the only competency acquired elsewhere was the effects of engine operating temperature which was acquired in college by 67 percent of the teachers.

Sixty-six percent of the teachers were teaching or using cooling system competencies. The use of a radiator cap tester was taught by less than a majority of the teachers (30 percent).

Teachers were teaching and using cooling system competencies but acquiring them primarily on the job with the exception of the effects of engine operating temperature on wear rate, power output, and fuel consumption, which was acquired by 67 percent of the teachers in their college courses. It seems more instruction in cooling systems would be desirable in the pre-service POWER course.

**Governing systems**

Generally, the results in Table 9 show that 46 percent of the teachers would require some preparation to teach or use governing system competencies. Compared to most other competency categories, a relatively high average of 24 percent of the respondents would require much preparation to teach or use governing system competencies.

An average of 51 percent of the teachers acquired governing system competencies on the job. An average of 59 percent taught or used the competencies.

It would appear that governing systems was not included in the subject matter in the pre-service POWER course. At least one lecture period should include governing systems.
TABLE 9.--Teachers' competencies in cooling and governing systems with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td><strong>Cooling System:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Describe the effects of engine operating temperature on wear rate, power output, and fuel consumption</td>
<td>31%</td>
<td>61%</td>
<td>08%</td>
</tr>
<tr>
<td>Use and interpret the readings of a radiator and radiator cap tester</td>
<td>33</td>
<td>41</td>
<td>26</td>
</tr>
<tr>
<td>List the major causes of engine overheating and explain how each might be corrected</td>
<td>50</td>
<td>42</td>
<td>08</td>
</tr>
<tr>
<td>List and describe the functions of the various engine liquid cooling system components</td>
<td>52</td>
<td>44</td>
<td>04</td>
</tr>
<tr>
<td>Service a liquid cooling system in preparation for cold weather operation</td>
<td>74</td>
<td>19</td>
<td>07</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>48</td>
<td>41</td>
<td>11</td>
</tr>
<tr>
<td><strong>Governing System:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remove and replace a governor</td>
<td>19%</td>
<td>50%</td>
<td>31%</td>
</tr>
<tr>
<td>Describe the general operation and function of an engine governing system</td>
<td>19</td>
<td>62</td>
<td>19</td>
</tr>
<tr>
<td>Set engine high idle rpm by adjusting the governor and/or the governor linkage on a specified engine</td>
<td>52</td>
<td>26</td>
<td>22</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>30</td>
<td>46</td>
<td>24</td>
</tr>
</tbody>
</table>
oil index, oil viscosity, and crankcase ventilation systems by more than 50 percent of the respondents.

As a general category, competencies in lubrication systems were acquired in college by an average of 38 percent of the teachers. Only the competency involving the functions of the lubrication system components was acquired on the job by as high as 44 percent of the respondents. Diagnosing oil consumption was acquired by 37 percent of the teachers in high school while 70 percent of the teachers learned to change the oil and oil filter in work experience.

An average of 79 percent of the teachers were teaching the competencies in the lubrication systems category. Generally, teachers seemed to be fairly well prepared in this area. Teachers appeared to be weak in competencies concerning A.P.I. service classification, oil viscosity index, and crankcase ventilation systems. These three competencies could receive more emphasis in the pre-service POWER course.

Cooling systems

Data presented in Table 9 show that an average of 48 percent of the teachers would require little preparation in teaching or using cooling system competencies. Description of the effects of engine operating temperature would require some preparation by as high as 61 percent of the respondents.
TABLE 8.—Teachers' competencies in lubrication systems with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Lubrication Systems:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>List and explain the meaning of A.P.I. oil service classifications</td>
<td>26%</td>
<td>56%</td>
<td>18%</td>
</tr>
<tr>
<td>Describe the operation and maintenance of the crankcase ventilation system</td>
<td>35</td>
<td>54</td>
<td>11</td>
</tr>
<tr>
<td>Describe the meaning of oil viscosity index</td>
<td>38</td>
<td>58</td>
<td>04</td>
</tr>
<tr>
<td>Select an appropriate oil to be used in a tractor engine given the operating and weather conditions</td>
<td>50</td>
<td>46</td>
<td>04</td>
</tr>
<tr>
<td>List and explain the functions of the various engine lubricating system components</td>
<td>52</td>
<td>48</td>
<td>00</td>
</tr>
<tr>
<td>List the possible causes of excess engine oil consumption and explain how to determine each</td>
<td>56</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td>Explain the meaning of a multi-viscosity oil</td>
<td>58</td>
<td>31</td>
<td>11</td>
</tr>
<tr>
<td>List the functions of oil in a tractor engine</td>
<td>73</td>
<td>27</td>
<td>00</td>
</tr>
<tr>
<td>Change the oil and oil filter of an engine</td>
<td>85</td>
<td>00</td>
<td>15</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>54</td>
<td>40</td>
<td>08</td>
</tr>
</tbody>
</table>
TABLE 7.—Teachers' competencies in intake and exhaust systems with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent (N = 27)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td><strong>Intake and Exhaust Systems:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>List the effects of adding a turbocharger to an engine not originally</td>
<td>15%</td>
<td>46%</td>
<td>39%</td>
</tr>
<tr>
<td>equipped with a turbocharger</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>List the precautions in operating a tractor equipped with a turbocharger</td>
<td>18</td>
<td>56</td>
<td>26</td>
</tr>
<tr>
<td>Describe the operation and purpose of a supercharger and a turbocharger</td>
<td>33</td>
<td>34</td>
<td>33</td>
</tr>
<tr>
<td>Explain the importance and function of various types of air cleaners</td>
<td>48</td>
<td>41</td>
<td>11</td>
</tr>
<tr>
<td>List and explain the functions of the intake and exhaust system</td>
<td>50</td>
<td>50</td>
<td>00</td>
</tr>
<tr>
<td>components</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain the importance of correct valve clearance</td>
<td>58</td>
<td>38</td>
<td>04</td>
</tr>
<tr>
<td>Set valve clearance</td>
<td>61</td>
<td>31</td>
<td>08</td>
</tr>
<tr>
<td>Service air cleaners and air intake systems</td>
<td>69</td>
<td>27</td>
<td>04</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>44</td>
<td>40</td>
<td>16</td>
</tr>
</tbody>
</table>
Intake and exhaust systems

According to data in Table 7, an average of 16 percent of the teachers would require much preparation to teach or use competencies concerning intake and exhaust systems. However, from 26 to 39 percent of the teachers would require much preparation to teach competencies involving turbocharging engines.

Competencies in the intake and exhaust area were acquired in college by an average of 42 percent or on the job by an average of 38 percent of the teachers. The competency of servicing air cleaners was acquired by 35 percent of the teachers in work experience. Although approximately one-third or more of the respondents acquired competencies concerning turbochargers in college, the other two-thirds relied on either work experience or one-the-job experience for acquiring turbocharging competencies.

Teachers were teaching the competencies in the intake and exhaust area with the exception of competencies that concerned turbochargers. At least two-thirds of the teachers were not teaching competencies involving turbochargers. Since it is not uncommon for larger tractors to be equipped with turbochargers, it would seem that more information in the area of turbochargers would be desirable in the pre-service POWER course.

Lubrication systems

The competencies in the category of lubrication systems did not require much preparation to teach or use except for an average of 8 percent of the teachers, as shown by information in Table 8. It would require some preparation to teach or use competencies concerning A.P.I.
TABLE 6.---Teachers' competencies in engine classification and basics with regard to amount of preparation needed to teach, where acquired, and whether taught or used, in percent \((N = 27)\)

<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Determine rod and main crankshaft bearing wear</td>
<td>23%</td>
<td>50%</td>
<td>27%</td>
</tr>
<tr>
<td>Use and interpret the readings of a compression gauge</td>
<td>39%</td>
<td>46%</td>
<td>15%</td>
</tr>
<tr>
<td>Identify engine types by classification of fuel used, valve arrangement,</td>
<td>48%</td>
<td>48%</td>
<td>04%</td>
</tr>
<tr>
<td>cylinder arrangement, method of cooling, and displacement</td>
<td>59%</td>
<td>30%</td>
<td>11%</td>
</tr>
<tr>
<td>Identify engine parts by name and function</td>
<td>65%</td>
<td>31%</td>
<td>04%</td>
</tr>
<tr>
<td>Remove and replace a cylinder head and gasket</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEAN</td>
<td>47%</td>
<td>41%</td>
<td>12%</td>
</tr>
</tbody>
</table>
equipment. It can be used to teach power measurement in addition to its use as an engine diagnostic tool. However, dynamometers are relatively expensive, occupy valuable shop space, and are used relatively infrequently. Therefore, many teachers may not have a dynamometer in their school shops.

**Engine classification and basics**

According to the information in Table 6, an average of 12 percent of the teachers would require much preparation to teach or use competencies in the engine classification and basics category. Determining rod and main bearing wear would require some to much preparation by 77 percent of the respondents. Since teachers usually emphasize engine maintenance rather than overhaul, this competency might be eliminated from consideration as a college topic.

As a general category of competencies, an average of 42 percent of the teachers acquired them on the job. Only removal and replacement of a cylinder head was acquired in work experience by as many as 40 percent of the respondents. Seemingly, the ability to identify engine parts was acquired from a variety of sources with no one source indicated by more than 30 percent of the teachers.

An average of 67 percent of the teachers taught or used these competencies but an average of only 19 percent of the teachers acquired them in college. It is recommended that the subject matter area of engine classification and basics receive more emphasis in the pre-service POWER course.
<table>
<thead>
<tr>
<th>Competency</th>
<th>Preparation needed</th>
<th>Where acquired</th>
<th>Taught or used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Little</td>
<td>Some</td>
<td>Much</td>
</tr>
<tr>
<td>Engine Fundamentals:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Define and explain the importance of an engine's lugging ability</td>
<td>16%</td>
<td>60%</td>
<td>24%</td>
</tr>
<tr>
<td>Determine tractor horsepower using a portable dynamometer</td>
<td>19</td>
<td>62</td>
<td>19</td>
</tr>
<tr>
<td>Define indicated, friction, flywheel, brake, belt, drawbar, PTO, and rated horsepower</td>
<td>33</td>
<td>59</td>
<td>08</td>
</tr>
<tr>
<td>Define energy, inertia, force, torque, work, power, and horsepower</td>
<td>35</td>
<td>54</td>
<td>11</td>
</tr>
<tr>
<td>Calculate displacement and compression ratio given the necessary factors</td>
<td>41</td>
<td>41</td>
<td>18</td>
</tr>
<tr>
<td>Compare the two-stroke cycle engine with the four-stroke cycle engine in terms of power, weight, efficiency, and application</td>
<td>54</td>
<td>35</td>
<td>11</td>
</tr>
<tr>
<td>Define bore, stroke, displacement, and compression ratio</td>
<td>58</td>
<td>31</td>
<td>11</td>
</tr>
<tr>
<td>List and explain the two strokes of a two-stroke cycle engine</td>
<td>74</td>
<td>22</td>
<td>04</td>
</tr>
<tr>
<td>List and explain the four strokes of a four-stroke cycle engine</td>
<td>85</td>
<td>04</td>
<td>11</td>
</tr>
<tr>
<td><strong>MEAN</strong></td>
<td>46</td>
<td>41</td>
<td>13</td>
</tr>
</tbody>
</table>
Competencies in POWER Subject Matter Area

Engine Fundamentals

As shown in Table 5, an average of only 13 percent of the teachers would require much preparation to teach competencies in engine fundamentals. However, more than 50 percent of the teachers would require some preparation to teach basic physics terms, various methods of determining horsepower, use of a dynamometer, and explaining the importance of an engine's lugging ability.

An average of 46 percent of the teachers acquired the competencies in college. Explanation of the two- and four-stroke cycles was acquired in high school by 40 percent of the teachers. The only competency acquired on the job by as many as 48 percent of the teachers involved the comparison of the two- and four-stroke cycle engines. The next highest percentage of teachers indicating the competency was learned on the job was only 28 percent.

An average of 65 percent of the teachers taught or performed this category of competencies. Notable exceptions to this trend were use of the dynamometer and explaining the importance of an engine's lugging ability, which were taught or used by only 15 and 23 percent of the teachers, respectively.

More emphasis should be placed on the comparison of the two- and four-stroke cycle engine and the importance of an engine's lugging ability in the pre-service POWER course. Determining the horsepower of an engine using a portable dynamometer was taught or used by the lowest percentage (15 percent) of the teachers of any competency in this category. A portable dynamometer is a useful item of shop
strongly disagree (Appendix C). The category of troubleshooting in POWER and safety in CONMAINT were relatively high compared to other categories. These seemed to be no apparent pattern to the higher ranked general categories. In fact, the responses by the panel of experts resulted in safety being ranked, as to agreement that it should be taught, first in CONMAINT and eighth in POWER areas. The lower ranking categories contained specific competencies discussed previously.

**Competency Organization**

The final three objectives of this study were to determine: (1) the amount of preparation needed to teach a competency, (2) where the competency was acquired, and (3) whether or not the competency was taught at the high school level or used by the teacher.

Because of the nature of these objectives and the number of competencies involved, the remainder of this chapter will be organized so as to consolidate competencies into general categories and briefly discuss all three objectives in each category. In addition, the competencies will be listed in the tables in the order of the amount of preparation, from high to low, needed by teachers to teach or use the competencies.
As shown by the information in Table 4, of the 305 competencies in the subject matter area of Agricultural Engineering 240 (CONMAINT), over 94 percent fell into the categories of "strongly agree" and "agree" which indicates that, as a whole, the panel of experts thought the competencies should be included in the pre-service courses taught in the Agricultural Engineering Department.

<table>
<thead>
<tr>
<th>Response</th>
<th>Weighting</th>
<th>Number of competencies</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
<td>3.50 to 4.00</td>
<td>52</td>
<td>17.0</td>
</tr>
<tr>
<td>Agree</td>
<td>2.50 to 3.49</td>
<td>235</td>
<td>77.1</td>
</tr>
<tr>
<td>Disagree</td>
<td>1.50 to 2.49</td>
<td>18</td>
<td>5.9</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>1.00 to 1.49</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>305</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Only about 6 percent, or 18, of the competencies were in the "disagree" category. Some of these competencies that the panel of experts rejected were outmoded competencies involving such things as rope, leather, forging skills, and the sharpening of certain hand tools. Other competencies dealt with more sophisticated machines such as milling machines or shapers which are more likely to be found in shops used by industrial arts or trades and industries teachers rather than in vocational agriculture shops.

When considered by general categories of competencies, with the exception of competencies that dealt with crawler tractor tracks in POWER and leather work in CONMAINT, all categories received a mean value of 2.5 or over on the scale of 4.0—strongly agree—to 1.0—
As shown by the data in Table 3, of the 175 competencies that might be categorized into the subject matter area of Agricultural Engineering 230 (POWER), about 92 percent received a mean value rating in the categories of "strongly agree" and "agree" while only about 8 percent of these competencies received the mean value rating of "disagree." No competency had a mean value that would place it in the "strongly disagree" category.

### TABLE 3.--Ratings of POWER competencies by a panel of experts as to the need to be taught in pre-service agricultural engineering courses

<table>
<thead>
<tr>
<th>Response</th>
<th>Weighting</th>
<th>Number of competencies</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
<td>3.50 to 4.00</td>
<td>57</td>
<td>32.6</td>
</tr>
<tr>
<td>Agree</td>
<td>2.50 to 3.49</td>
<td>104</td>
<td>59.4</td>
</tr>
<tr>
<td>Disagree</td>
<td>1.50 to 2.49</td>
<td>14</td>
<td>8.0</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>1.00 to 1.49</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>175</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

In the POWER subject matter area, the 14 competencies that fell into the category "disagree" included those general competencies dealing with the explanation or calculation of displacement; power and thermal efficiency of engines; working with gears, tires, and tracks; and the repair and testing of diesel fuel systems (Appendix C). Most of these competencies rejected by the panel of experts were competencies requiring either little or extensive formal education and those of an equipment design nature.
electives. If teachers are expected to spend 30 to 40 percent of their time teaching agricultural mechanics, the amount of course work taken in the Agricultural Engineering Department appeared to be inadequate.

<table>
<thead>
<tr>
<th>Course number</th>
<th>Course title</th>
<th>Percent selecting</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>Machines for Agricultural Operations</td>
<td>47.1</td>
</tr>
<tr>
<td>220</td>
<td>Buildings and Equipment for Farmstead Operations</td>
<td>23.5</td>
</tr>
<tr>
<td>550</td>
<td>Pollution Control and Waste Utilization</td>
<td>19.6</td>
</tr>
<tr>
<td>231</td>
<td>Electrical Power for Agricultural Operations</td>
<td>17.6</td>
</tr>
<tr>
<td></td>
<td>Other (including graduate studies)</td>
<td>17.6</td>
</tr>
<tr>
<td>270</td>
<td>Engineering Methods in Soil and Water Conservation</td>
<td>15.7</td>
</tr>
<tr>
<td>221</td>
<td>Agricultural Materials Handling Systems</td>
<td>9.8</td>
</tr>
<tr>
<td>593</td>
<td>Individual Studies</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Competency Selection

The first specific objective of this study was to develop a list of desirable agricultural mechanics competencies that teachers of vocational agriculture should acquire in the two required agricultural engineering courses. Specifically, they are Agricultural Engineering 230, Power for Agricultural Operations (POWER), and Agricultural Engineering 240, Teaching of Agricultural Construction and Maintenance (CONMAINT).
even competencies, there was less than one-tenth of a year of service difference in the means of these two groups, which tends to verify that the teachers were divided into equal groups.

**Agricultural Mechanics Education**

To determine the formal education background of vocational agriculture teachers in agricultural mechanics subject matter, teachers were asked to check courses that they had taken in the Agricultural Engineering Department and to list any that were not included in the checklist. This was to determine the general background in the agricultural mechanics subject matter area and to serve somewhat as an overall indicator of teachers' interest in the field of agricultural mechanics.

As indicated in Table 2, no agricultural engineering course was elected by the majority of the respondents, although Agricultural Engineering 250, Machines for Agricultural Operations, was elected by nearly 50 percent of the respondents. No other course was elected by as many as 25 percent of the responding teachers.

Of the agricultural engineering elective courses available to them, teachers took a mean of 1.5 agricultural engineering courses beyond the two specifically required three credit hour courses. Since one other three-hour agricultural engineering elective is required (a total of nine quarter hours), this means that teachers took a mean of 0.5 courses in agricultural engineering as a part of their free
CHAPTER IV

FINDINGS AND DISCUSSION

After a brief paragraph concerning the teaching experience of the respondents, this chapter is organized in the same order as the specific objectives. The first specific objective--developing a list of desirable agricultural mechanics competencies that teachers of vocational agriculture should acquire in the two required courses taught in the Agricultural Engineering Department--will be discussed separately. Each of the other three specific objectives--amount of preparation required to teach or use selected agricultural mechanics competencies, where the competencies were acquired, and whether or not the competencies are taught at the high school level or used by the teacher--will be discussed as it pertains to a general category of competencies. A final section of this chapter will summarize the findings.

Experience of Respondents

On a general information sheet preceding the list of competencies, teachers were asked to indicate their years of service to ascertain that they had taught from two to four years. The mean years of service of all teachers was nearly three years (2.96), as shown in Table 34, Appendix F. As randomly divided to respond to the odd and
On a follow-up of the 10 nonrespondents, it was found that four had left the teaching profession and no longer had any interest in completing the survey, two finally agreed to complete the survey but did not, two refused because of a busy schedule, and two could not be contacted. Of the 63 teachers qualified to participate, the overall response rate was 84 percent.

Data Analysis

Information on the usable answer sheets was then coded and the data recorded on computer cards. The Statistical Package for Social Sciences (SPSS) program was used to find the number and percentage of teachers in each response category. Generally, measures of central tendency and deviations from central tendency were used to analyze the information.
Respondents

As shown in Table 1, 80 teachers of vocational agriculture were identified as having completed two, three, or four years of service. Of the 80 teachers who were sent a list of agricultural mechanics competencies, 17 did not qualify for a variety of reasons. Most teachers that were disqualified were not eligible to participate in the study because they either had not graduated from The Ohio State University or were in a multiple teacher department and had not taught agricultural mechanics since graduation. A few teachers had graduated before 1968 but were in their second to fourth year of teaching because they had only recently entered the teaching profession. These teachers' opinions were not included in the study because of the length of time since graduation.

### TABLE 1.--Number and percent of vocational agriculture teachers surveyed by years of service

<table>
<thead>
<tr>
<th>Years of service</th>
<th>Number as identified</th>
<th>Teachers qualified</th>
<th>Teachers not qualified</th>
<th>Usable responses</th>
<th>Responses as percentage of qualified</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>32</td>
<td>26</td>
<td>6</td>
<td>22</td>
<td>84.6</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>22</td>
<td>8</td>
<td>18</td>
<td>81.8</td>
</tr>
<tr>
<td>4</td>
<td>18</td>
<td>15</td>
<td>3</td>
<td>13</td>
<td>86.7</td>
</tr>
<tr>
<td>Total</td>
<td>80</td>
<td>63</td>
<td>17</td>
<td>53</td>
<td>84.1</td>
</tr>
</tbody>
</table>

Fifty-three usable responses were received from the remaining 63 eligible teachers. Twenty-six responses were from the group of teachers assigned the "ODD" group of competencies; 27 responses were from the group of teachers responding to the "EVEN" competencies.
Sample of Teachers

The sample of teachers selected to receive this survey included all the teachers completing their second, third, or fourth year of teaching vocation production agriculture in the State of Ohio. Teachers with four or fewer years of service were chosen because it was assumed that they had had sufficient experience to provide valid reactions, yet would not have been out of college long enough to have forgotten their college classroom learning experiences, and would remember where and when their agricultural mechanics competencies were acquired. Using a table of random numbers, the 80 teachers so identified were then randomly assigned to one of two groups of 40 teachers to receive either the "ODD" or the "EVEN" list of competencies.

The instrument, along with a cover letter, was mailed on June 4, 1974 (Appendix E). A letter encouraging the teachers to participate in the study was sent from Johnson's office dated June 12, 1974 (Appendix D). On June 18, 1974, nonrespondents were sent a follow-up letter asking for a response and offering to send a second questionnaire if desired (Appendix D). On July 9, 1974, most nonrespondents were personally contacted at the annual seminar of the Ohio Vocational Agriculture Teachers Association and encouraged to participate in the study. At the same seminar district supervisors were queried concerning nonrespondents not in attendance to verify the teacher's eligibility and mailing address. A final follow-up letter to the few remaining eligible nonrespondents was sent on July 17, 1974 (Appendix D).
receiving the highest weighted mean values were included in an instru-
ment which was pretested for clarity by using a group of graduate
students who were former teachers of vocational agriculture. Evalua-
tion of the pretest indicated that the instrument was excessive in
length, that reaction to each competency required an average of about
30 seconds, and that one hour was about the limit of time that a teacher
might spend in such an endeavor. Based on those evaluations, two re-
vised instruments limited to 120 competencies each were developed, as
explained below. This number of competencies would reduce the time re-
quired to complete the instrument to approximately one hour.

In order to obtain teachers' reactions to a greater number of
competencies and hoping to avoid a limited response which could result
because of the length of the original questionnaire, it was decided to
randomly divide the sample of teachers into two groups. One group re-
ceived an instrument of 120 of the 240 highest ranked competencies
containing the odd numbered items. This group was designated "ODD"
as they were asked to react to competencies 1, 3, 5, 7, . . . 239
from the high ranking competencies as determined by ratings of the
panel of experts. A second group was designated "EVEN" and asked to
react to the top 120 even numbered competencies--2, 4, 6, 8, . . . 240.
This panel was considered to be sufficient in number, experience, and expertise to adequately identify competencies needed by teachers of vocational agriculture in Ohio that should be included in the subject matter areas of POWER and CONMANT.

On February 18, 1974, panel members were sent a letter informing them of their selection and asking them to participate in this study (Appendix A). On March 7, 1974, the panel members were sent the list of 480 competencies and asked to rate each competency either strongly agree, agree, disagree, or strongly disagree that each competency should be included in the pre-service courses taught in the Agricultural Engineering Department (Appendix B). A follow-up letter from Johnson of the Agricultural Engineering Department was mailed on March 15, 1974, stressing the importance of participating and urging a complete and prompt response (Appendix A).

If a teacher chose not to participate for some reason, the alternate teacher from the same district was asked to participate. A final follow-up letter was mailed on March 29, 1974, to nonrespondents, and a 100 percent response was achieved by April 15, 1974.

The responses from the panel of experts were weighted (4.0--strongly agree, 3.0--agree, 2.0--disagree, 1.0--strongly disagree) and a mean value was calculated for each competency. The ratings of the competencies were then ranked by their mean values in order from the highest to the lowest (Appendix C).

Approximately one-half of the 480 competencies evaluated by the panel of experts received a mean value of 3.0 or over (agree to strongly agree that the competency should be taught). The 240 competencies
Panel of Experts

The panel of experts included 14 experienced vocational agriculture teachers, one supervisor and one teacher educator from agricultural education, and two professors from agricultural engineering. The vocational agriculture teachers were identified in response to a request mailed January 10, 1974, to area supervisors of vocational agriculture teachers (Appendix A). The supervisors were asked to recommend teachers especially knowledgeable in agricultural mechanics with five or more years experience who were teaching a balanced curriculum of production agriculture. For geographical distribution, supervisors were asked to name one teacher and one alternate from each of the 14 vocational agriculture supervisory districts in Ohio.

The panel also included Richard S. Hummel, an assistant state supervisor of vocational agriculture teachers, who was responsible for statewide leadership in agricultural mechanics instruction at the supervisory level, and Richard H. Wilson, a teacher educator in the Department of Agricultural Education at The Ohio State University, who has provided leadership in directing teacher supervisors of student teachers and has observed teaching by teachers and student teachers throughout the state. The final two panel members were Samuel G. Huber and Carlton E. Johnson, professors in the Department of Agricultural Engineering at The Ohio State University. Huber was responsible for instruction in Agricultural Engineering 230, Power for Agricultural Operations, and Johnson was responsible for instruction in Agricultural Engineering 240, Teaching of Agricultural Construction and Maintenance.
were asked to react to each competency as to: (1) the amount of preparation required to teach or use the competency, (2) where they had acquired the ability, and (3) whether they actually taught or used the competency. The responses of this group of teachers were then analyzed to fulfill the specific objectives of this study.

Development of the Competency List

During the autumn quarter of 1973, a comprehensive list of agricultural mechanics competencies that might be taught in the subject matter areas of Power for Agricultural Operations and Agricultural Construction and Maintenance was developed. This list included competencies from various textbooks, from previous studies, and from direct observation by the author while auditing classes in Agricultural Engineering 230, Power for Agricultural Operations (assigned the acronym POWER in subsequent references), and Agricultural Engineering 240 (assigned the acronym CONMAINT in subsequent references). In developing the comprehensive list of competencies, no attempt was made to limit or select certain competencies other than to include subject matter appropriate to POWER and CONMAINT. Competencies were classified into 27 subject matter sub-areas for POWER and into 22 subject matter sub-areas for CONMAINT (Appendix B). Duplicate and related competencies were combined; others were edited to achieve a similar format. The final list was comprised of 175 competencies that might conceivably be included in the area of POWER and 305 competencies that might conceivably be included in the CONMAINT area (Appendix B).
CHAPTER III

PROCEDURE

In order to accomplish the objectives of this study, a comprehensive list of agricultural mechanics competencies was developed for the subject matter areas usually included in the courses Power for Agricultural Operations and Teaching of Agricultural Construction and Maintenance. This list was then submitted to a panel of experts that included experienced vocational agriculture teachers, a supervisor of vocational agriculture teachers, an agricultural education teacher educator, and two agricultural engineering professors. Each member of the panel was asked to indicate a level of agreement (strongly agree, agree, disagree strongly, disagree) as to whether each competency should be included in the required pre-service agricultural mechanics courses taught in the Agricultural Engineering Department. The categories of agreement for rating the competencies were given numerical values and a mean value was calculated for each competency according to the composite responses by this panel of experts. The competencies were then rank ordered from the most to the least desirable as a competency that should be taught in the agricultural mechanics pre-service courses taught in the Agricultural Engineering Department. The more desirable competencies, as ranked, were then submitted to all Ohio teachers of vocational production agriculture with two to four years teaching experience. These teachers
Summary of Review of Literature

Most studies have surveyed people actively engaged in production agriculture and vocational agriculture teachers in an attempt to determine the more important agricultural mechanics competencies needed by teachers. Based on the results of these studies, writers did not agree, with few exceptions, upon which competencies or categories of competencies are most important. Teachers and teacher educators did agree that teachers needed increased competence in teaching agricultural mechanics skills. The competencies that teachers possessed were primarily acquired on the job with college as the second most important source. Teachers were not teaching all of the competencies that studies showed were important, citing lack of tools, equipment, and facilities as the primary reasons.
Several studies have included an objective of finding out where teachers acquired their agricultural mechanics competencies. Research studies by Ahalt and Miller (1955), Johnson and Bear (1969), and Holley (1957) are all in agreement that competencies in agricultural mechanics are acquired primarily on the job and secondarily in college. Only Dettman's (1965) study reverses this order. Ahalt and Miller (1955) rank work experience third and high school fourth as sources of competency acquisition.

Several writers have investigated whether teachers are teaching competencies found important in surveys. Ahalt and Miller (1955) found that about 70 percent of the teachers were teaching all of the skills in their survey. Other writers have found that teachers were not teaching all of the desirable agricultural mechanics competencies but did not specify what percentage. Henderson (1949) found that, when questioned about why certain agricultural mechanics competencies were not taught, teachers cited lack of facilities and equipment and lack of ability in certain areas. Tugend (1964) found a lack of equipment as the reason teachers were not teaching certain competencies. As a result of his study, Nelson (1967) concluded that tools and equipment facilitated instruction and that the more shop equipment and facilities a teacher has the more hours a teacher will spend teaching agricultural mechanics skills. Omweg (1963), on the other hand, concluded that shop space was not an absolute necessity for teaching all areas of farm mechanics.
arc and oxy-acetylene welding, cold metal work, and carpentry and construction. Categories such as tool fitting, concrete, plumbing, and painting were mentioned but less frequently than those above. Studies recommending less instruction in certain areas agreed that forge and rope work might be eliminated.

Few studies were found that were focused on the vocational agriculture teacher and the level of difficulty in teaching certain competencies, where they were acquired, and whether or not they were taught or used. Gullor (1970) found that first-year teachers perceived their ability to teach agricultural mechanics at 2.5 (on a scale from 1—not possess the ability—to 7—demonstrated the ability without assistance) at the beginning of the year and at 4.8 at the end of the first year. However, in both instances, the rating was next to last in the 10 categories of abilities. Johnson and Bear (1969) found that teacher educators believed that the competency level of teachers was less than they desired in a Minnesota study. Hoerner (1968), in a survey of teachers in in-service agricultural mechanics, also found that the needed competence in teaching agricultural mechanics competencies was less than the level of possessed competence. A second phase of Ryder's (1954) study was to determine the adequacy of teachers' preparation for teaching selected areas of farm mechanics by surveying 135 Ohio teachers. He found that teachers desired additional preparation in plumbing, concrete, welding, metal work, painting, soldering, woodworking, and tool fitting.
agricultural mechanics subject matter according to the teacher's time allotted to each area. On a larger geographical scale, Ahalt and Miller (1955) surveyed 132 teachers in the North Atlantic region concerning the importance of 205 farm mechanics skills in 17 categories. Dougan (1951) chose to use 34 experienced teachers, two from each of Ohio's 17 vocational agriculture districts, to help identify important shop skills needed by beginning teachers of vocational agriculture. Johnson and Bear (1969) employed teacher educators to rank competencies needed by teachers of vocational agriculture in Minnesota.

That teachers teach what they have been taught and tend to rank such skills highly on surveys is a circular pattern that several researchers have tried to break. Anthony (1956) used spare parts sales as an aid in determining what should be taught in the area of farm power and machinery. Farm machinery adjustments on selected farms in Minnesota was a criterion used by Bear and Solstad (1966) in determining needs for additional instruction in agricultural mechanics of both farmer and teachers. Diener (1967) utilized the opinions of parents as to what agricultural mechanics abilities they believed their children should be able to perform on graduation from high school.

Almost all sources agree upon the need for additional or improved instruction in the area of agricultural mechanics in vocational agriculture. However, the many studies that have been conducted are not in agreement, with a few exceptions, as to what competencies are most important. Most often mentioned categories of competencies found valuable in various studies were tractors and engines, field machinery,
of various areas of agricultural mechanics, Morford (1953) advocated a study of how a farmer spends his time. Other studies have specifically utilized the young farmer to identify agricultural mechanics competency needs. Miller (1949) asked vocational agriculture teachers from purposively selected Central Ohio departments to interview young farmers, while Kindschy (1948) surveyed 246 former students of vocational agriculture in Iowa presently enrolled in a young farmer class. Harris (1960) utilized farmers in Georgia that he divided into the categories of boy farmer, young farmer, and older farmer to determine the value of 138 farm shop abilities. To temper the information gained predominately from farmers, Baker (1964) and Bentley and Clouse (1960) included, in their research, lesser numbers of vocational agriculture teachers, agribusiness representatives, extension specialists, and teacher educators. Dettman (1965) used a panel of consultants composed of Iowa State University specialists and teachers of vocational agriculture to develop a list of 186 agricultural mechanics competencies.

Experienced teachers and teacher educators of vocational agriculture have also been used extensively for their acquired familiarity with the competency needs in teaching agricultural mechanics subject matter. Watkins (1959) submitted a questionnaire to 116 teachers of vocational agriculture to determine the status and recommendations for facilities of vocational agriculture particularly for the farm mechanics program in Ohio. Using a slightly different approach in his effort to determine areas, needs for instruction, facilities and equipment available, and needs for equipment in the farm mechanics programs in the departments of vocational agriculture in Iowa, Henderson (1949) weighted
CHAPTER II

REVIEW OF LITERATURE

The determination of which agricultural mechanics competencies are more important for teachers of vocational agriculture to possess and use has been the subject of many studies. There is some disagreement among researchers as to who is best qualified to make such a determination, but most studies have utilized people actively engaged in production agriculture for the source of such information.

As early as 1927, Kennedy sought to further the instruction in agricultural mechanics in Ohio by surveying the farmers who were fathers of students in vocational agriculture in an attempt to identify the types of mechanical jobs being performed on Ohio farms. In a later study, Ryder (1954) enlisted the aid of four teachers in each of the 15 vocational agriculture supervisory districts of Ohio to select and administer a check list of 375 farm mechanics items to farmers in an effort to aid in the development of a balanced and effective program of preparing teachers of vocational agriculture in farm mechanics. On a more localized level, Skadburg (1972) surveyed the farmers in his school district in Iowa and asked them to rate the value of 64 mechanical skills and abilities. In Maryland, Tugend (1964) asked 80 successful farm operators to indicate which of 100 mechanical skills were used in their farming operations. As an indication of the relative importance
POWER--an acronym for Agricultural Engineering 230 derived from the course title, "Power for Agricultural Operations."

Young teachers--teachers of vocational agriculture with two, three, or four years of teaching experience.
Specific Objectives

The specific objectives of this study were to:

1. Determine the more important agricultural mechanics competencies prospective teachers of vocational agriculture should acquire in the two specifically required agricultural engineering courses.

2. Determine the amount of study and assistance young teachers of vocational production agriculture would require to teach or use selected agricultural mechanics competencies.

3. Determine whether young teachers of vocational agriculture acquired selected agricultural mechanics competencies during previous work experience, in high school, in college, or while on the job.

4. Determine which of the selected agricultural mechanics competencies young teachers of vocational agriculture are teaching or performing.

Definitions

Certain terms used in this study are defined below to facilitate understanding for the reader:

CONMAINT—an acronym for Agricultural Engineering 240 derived from the course title, "Teaching of Agricultural Construction and Maintenance."
the preparation of teachers of agriculture in agricultural mechanics:

1. Agricultural engineering departments are devoting less and less time to practical approaches to teaching.

2. Agricultural engineering department faculties debate as to whether they should offer any courses to train students in mechanics.

3. Reduction in the amount of time available to teach mechanics in the agricultural education curriculum (p. 171).

In a summary of a national study to determine the arrangements in institutions with teacher education programs in agriculture relative to the staffing of program specialists and administration of agricultural mechanics, it was stated:

Evidence seems to indicate there is no common agreement on how to prepare teachers of vocational agriculture in agricultural mechanics. No one is taking the major responsibility for determining what the undergraduate curriculum should be, nor do they seem to be concerned. The responsibility tends to float between various departments with agricultural engineering doing most of the teaching. Few curriculum innovations appear to be taking place (Salmon: 1969, p. 75).

Purpose of the Study

The major purpose of this study was to determine desirable agricultural mechanics competencies that should be taught to prospective teachers of vocational agriculture in the two agricultural engineering courses specifically required in the pre-service production curriculum.
a greater percentage, 71 percent, favored more required courses in agricultural engineering than in other technical areas.

In spite of the apparent need for more courses to prepare teachers to teach agricultural mechanics, the trend in some institutions has been to fewer courses and away from courses designed specifically for prospective teachers. At The Ohio State University in 1958, a five credit hour course in farm power and electricity, designed specifically for teachers of vocational agriculture, was replaced by a three credit hour general farm power course, Agricultural Engineering 230. The condensation of this course eliminated the portion of the course dealing with electricity. A required course in field machinery, Agricultural Engineering 512, was replaced by a three credit hour agricultural engineering elective. Agricultural Engineering 504, dealing with agricultural construction and maintenance, was renumbered Agricultural Engineering 240 and reduced from five to three credit hours. The reduction in hours caused instruction in soldering to be eliminated and the time spent on oxy-acetylene welding to be reduced. As a result of these changes, it was expected that prospective teachers would then take 5 three credit hour agricultural engineering courses and broaden their understanding of the agricultural engineering phases of vocational education in agriculture. Instead, the 15 credit hour requirement of courses in the Agricultural Engineering Department was reduced to nine credit hours.

In a paper presented to the Central States Seminar in Agricultural Education in 1968, Weston (1969) reported the following trends in
based upon agricultural needs. The course meets for two hours of lecture and four hours of laboratory per week. A third Agricultural Engineering course can be elected from such technical subject matter areas as power and machinery, electrical power and processing, structures and environment, soil and water, or food engineering.

Students are not limited to nine quarter credit hours in agricultural mechanics, however. Additional courses in the Agricultural Engineering Department may be used to fulfill the 17 hours of electives in the "Technical Requirements in Agriculture" core.

Although a vocational agriculture teacher in Ohio may spend almost 40 percent of his time teaching agricultural mechanics, the total minimum requirement of courses involving agricultural mechanics represents 16 percent of the technical course requirements and only 5 percent of the total hours required for graduation.

Nationwide, the situation is not much better. In a survey of heads of agricultural education departments, Salmon (1969, p.73) found that an average of 18 quarter credit hours was required in agricultural mechanics for agricultural education majors, representing about 9 percent of the total baccalaureate degree requirements.

Teachers of vocational agriculture in Ohio recognize the need for more agricultural engineering courses. In a curriculum evaluation (A University Department Evaluates Its Curriculum, ...1958), graduates of the agricultural education curriculum were asked to identify areas in which they would favor additional requirements. Of the 250 respondents (about 80 percent either former or current teachers of agriculture)
hours required for graduation from The Ohio State University ("Agricultural Production Program. . .":1973). The nine quarter credit hours of agricultural mechanics taught in the Agricultural Engineering Department are included within a "Technical Requirements in Agriculture" core of 56 quarter credit hours and represent slightly over 16 percent of this area. There may be other courses that assist the beginning teacher to teach agricultural mechanics, but those courses involve primarily teaching methods rather than agricultural mechanics.

To fulfill the nine quarter credit hours required in agricultural mechanics, students take Agricultural Engineering 230 and Agricultural Engineering 240 and elect a third course. Agricultural Engineering 230, Power for Agricultural Operations, is a three quarter hour undergraduate credit course. The Agricultural Engineering Department considers it a general service course open to any student who has met the mathematics prerequisite. The course is a study of the use of horsepower in agriculture with primary emphasis upon power needs for field operations, characteristics of available power, sources, selection, and use of power units. The course meets for two hours of lecture and two hours of laboratory per week. Agricultural Engineering 240, Teaching of Agricultural Construction and Maintenance, is a three quarter hour undergraduate credit course. The course is offered primarily for agricultural education majors and specifies a prerequisite of, or concurrent enrollment in, Agricultural Education 230 or 330. Agricultural Engineering 240 is a course involving the principles and methods of teaching the selection, use, and care of hand and power tools as well as the selection of materials for wood and metal construction.
convenience, cabs, air-conditioning, power accessories, and monitoring of component systems may become standard. The vocational agriculture teacher will continue to experience a greater need for additional knowledge, understanding, and development of new skills as times goes on.

Teachers of vocational agriculture recognize the importance of agricultural mechanics in curriculum planning. It is estimated that across the nation vocational agriculture teachers devote 30 to 60 percent of their teaching time to instruction in agricultural mechanics (Weston:1969, p.171). In a study of the vocational agriculture curriculums in Ohio, Omweg (1963, p.15) determined that 38 percent of the vocational agriculture teacher's time was devoted to instruction in agricultural mechanics.

Many prospective teachers of vocational agriculture will not have developed the necessary experience and skills to successfully teach agricultural mechanics prior to the beginning of their college education. The implication, then, is that sometime during pre-service education a prospective teacher must acquire an understanding of basic physical principles as applied to agricultural mechanics and develop numerous mechanical skills through various learning experiences so he can teach agricultural mechanics in his first teaching position upon graduation. However, if pre-service education proves inadequate then teachers may have to rely on in-service education.

Examination of the teacher education curriculum for prospective teachers of vocational agriculture in Ohio revealed a minimum requirement of nine quarter credit hours in Agricultural Engineering Department courses representing about 5 percent of the total of 196 quarter credit
With increases in capacity, accuracy, and number of systems, it was inevitable that machinery would become more complex. With the greater number of systems, components, and functions, possibilities for malfunctions and failures increase rapidly. Owners and operators of farm equipment need to be ever more skilled in the operation, maintenance, and repair of equipment. If an owner or operator lacks sufficient skills, an alternative may be to have the local equipment dealer perform maintenance and repair and hire personnel to operate the equipment.

Implications for Teachers of Vocational Agriculture

The vocational production agriculture teacher (hereafter referred to as the vocational agriculture teacher), by virtue of his position, is expected to provide information and education to secondary school students enrolled in vocational production agriculture and to young and adult farmers in the operation, maintenance, and repair of equipment currently found in use in his community.

The vocational agriculture teacher thus finds the task of teaching agricultural mechanization subjects more complex and demanding as the development of mechanization continues. Relatively simple instruction involving rope, harness, and forging has given way to instruction in the operation and maintenance of diesel engines, hydraulic systems, air-conditioning, and electrical and electronic circuits.

The end of developments in agricultural mechanization is not in sight. Sophistication of agricultural equipment will continue, particularly in the areas of hydraulics and electronics. As equipment becomes larger and the operator demands more safety, comfort, and
CHAPTER I

INTRODUCTION

The mechanization of agricultural operations has developed relatively rapidly in the Twentieth Century. Yet, as early as the middle 1920s, Kennedy (1927) implied that mechanical problems as a result of farm mechanization in Ohio were becoming more numerous and complex when he wrote:

Only a short time ago the mechanical problems on the farm were few and simple. The equipment was very limited in amount and so simple that little repair work was needed to keep it in working order (p.1).

Since that time, the need for machines of greater capacity and for increased output per worker has prompted the manufacturing of machinery of an increased size. Many pieces of equipment have become so large that lanes, gates, and storage facilities are no longer adequate. Some machines must be partially disassembled to be transported any great distance on the highway. For additional efficiency, the precision and accuracy of many machine functions has been increased by the use of pneumatics, hydraulics, and electronics in the operation and control of equipment. Many times, in an effort to satisfy the desires for safety, comfort, and convenience, and in other cases to decrease the number of different field operations required, the number and sophistication of systems and components have become increasingly greater.

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COMPETENCIES NEEDED IN CONSTRUCTION, MAINTENANCE, AND ENGINE POWER BY TEACHERS OF VOCATIONAL AGRICULTURE

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

Miles Hillard Lovingood, B.S., M.S.

The Ohio State University

1977

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