

## TEACHING TRACTOR SERVICE SKILLS IN VOCATIONAL AGRICULTURE

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Increased mechanization characterized the agricultural sector of our economy during the decade of the 1970s. Each new model, especially agricultural tractors, featured changes to improve the efficiency and/or effectiveness of the machine. Myers (1977) stated that in recent years tractors have increased tremendously in size, cost, and complexity. The farmer cannot afford poor service and long downtimes on a tractor.

As mechanization increases on the farm, instruction in agricultural mechanization in a vocational agriculture program that emphasizes agricultural production, should also increase. Such agricultural mechanization instruction should include the service of agricultural tractors. Many studies have been conducted to identify the agricultural mechanics competencies needed by vocational agriculture students. Stull (1969) studied the skills needed by students who wished to become employed in agricultural machinery businesses; Webb and Knotts (1970) studied the agricultural mechanics skills needed by farmers in Texas, and Weber (1972) conducted a similar study in Louisiana. These and other studies have provided valuable information for curriculum guides, including one specifically developed for Iowa (Iowa State University, 1973), and competency-based instructional programs, including one for tractor mechanics (Carpenter and Iverson, 1977).

Much of the previous research and developmental efforts have treated agricultural mechanics as a general area or as a specific area, i.e. skills needed by people preparing for the occupation of "tractor mechanic." The problem lies in determining the agricultural tractor service skills which should be taught in an agricultural production vocational agriculture program, the grade levels at which these skills should be taught, and the degree of competence students should possess. Research completed at Iowa State University (Johnson, 1978) focused on this problem. The study involved vocational agriculture teachers, agricultural machinery service representatives, and agricultural mechanics teacher educators in providing data to help solve this problem. The assumption was made that these groups were in close contact with people operating agricultural tractors and should be aware of the service skills needed by operators. The research was designed to answer three specific questions, as follows:

1. Which agricultural tractor service skills should be taught in a secondary school agricultural production vocational agriculture program?

2. Which should the skills be taught?

3. What level of competence should students develop?

### *Methodology*

A list of 165 agricultural tractor service skills were identified through a review of the literature. This list was presented to a panel of six judges (agricultural mechanics teacher educators from midwestern universities) who were asked to identify the skills which should be taught in an agricultural production vocational agriculture program related to the service of agricultural tractors. If four of the six judges agreed that a specific skills should be taught, it was placed on the final questionnaire. Fifty-one skills met this criterion.

Respondents were instructed to indicate the degree of competence a student should possess upon completion of a program using a 1-to-9 scale, where 1 = little competence and 9 = much competence. In addition, teachers and teacher educators were asked to indicate the grade level at which each skill should be taught. The instrument was pilot tested with ten vocational agriculture teachers, four agricultural machinery service representatives and one teacher educator outside the population of this study.

The population for the study was: (1) 1977-78 vocational agriculture teachers in the 12-state central region of the United States (Michigan, Indiana, Ohio, Illinois, Wisconsin, Missouri, Iowa, Nebraska, South Dakota, North Dakota, Kansas, and Minnesota); (2) agricultural machinery service representatives in these 12 states from Ford, Massey Ferguson, International Harvester, and John Deere; and (3) agricultural mechanics teacher educators within the central region. The research sample included 287 randomly selected teachers, 151 agricultural machinery service representatives, and 18 agricultural mechanics teacher educators.

A copy of the questionnaire and a cover letter were mailed to individuals in the sample. A follow-up mailing was made to non-respondents. These procedures yielded returns from 66 percent of the teachers, 72 percent of the machinery service representatives, and 89 percent of the teacher educators.

### *Findings*

The findings are presented in four skill areas: (1) general tractor service skills (Table 1), (2) electrical system skills (Table 2), (3) fuel and cooling systems skills (Table 3), and (4) engine, power train, and drive skills (Table 4). For each skill area the competence mean for teachers, teacher educators, and service representatives are reported, plus a composite mean for the three groups of respondents. Also reported for each skill is the grade level at which teachers and teacher educators

felt the skill should be taught. (The reader should be aware that all 51 skills named in Tables 1-4 were judged by a panel of agricultural mechanics teacher educators in the preliminary stage of this research as ones that should be taught in an agricultural production vocational agriculture program in the central region.)

All three groups of respondents rated all 51 skills above five on a 9-point scale, indicating that they believed students should possess competence in all of these skills upon completion of a high school agricultural production vocational agriculture program. The composite competence mean ratings for the 51 skills ranged from a high of 7.70 for "setting ignition timing" (Table 2) to a low of 5.69 for "cleaning a tractor with a steam cleaner" (Table 1). In general, there was a tendency for teacher educators to rate the competence level needed by high school students higher than teachers and service representatives.

Table 1 presents twelve tractor service skills that were judged by the panel to be skills that should be taught in an agricultural production vocational agriculture program in the central region. Teachers, teacher educators, and agricultural machinery service representatives indicated that students should have competence in these areas upon completion of a high school agricultural production vocational agriculture program. The mean competence ratings ranged from a high of 8.00 by teacher educators for "changing an oil filter" to a low of 5.18 by machinery service representatives for "cleaning a tractor with a steam cleaner." The composite means ranged from a high of 7.19 for "maintaining a hydraulic cylinder" to a low of 5.69 for "cleaning a tractor with a steam cleaner."

Teachers and teacher educators indicated that seven of the general tractor service skills should be taught at the ninth grade level and five at the eleventh grade level, as shown in Table 1.

The tractor electrical skills, which the panel of judges said should be taught in an agricultural production vocational agriculture program, are listed in Table 2. These fourteen skills had mean competence ratings that ranged from a high of 8.43 by teacher educators for "setting ignition timing" and "replacing ignition points and condensers" to a low of 5.50 by machinery service representatives for "treating battery terminals to prevent corrosion." With the exception of three ratings by agricultural service representatives (skills 7, 10, and 12), skill competence ratings were above 6.0 on a 9-point scale, indicating that vocational agriculture students in agricultural production curriculums should have a rather high level of competence in these skills upon completion of high school. "Setting ignition timing," "replacing ignition points and condensers," and "setting ignition points" have the highest composite means of any of the 51 skills studied.

Table 1  
 MEAN COMPETENCE LEVEL STUDENTS SHOULD POSSESS FOR GENERAL TRACTOR SERVICE SKILLS

Skills	Composite Competence		Teacher Competence		Teacher Educator Competence		Service Rep Competence	
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
1. Maintaining a hydraulic cylinder <sup>3*</sup>	7.19	7.19	7.19	7.50	7.14			
2. Charging a wet cell battery <sup>1</sup>	7.19	7.47	7.81	6.63				
3. Servicing an oil-type air cleaner <sup>1</sup>	6.96	7.37	7.93	6.10				
4. Changing an oil filter <sup>1</sup>	6.90	7.44	8.00	5.78				
5. Changing engine oil <sup>1</sup>	6.88	7.44	7.87	5.76				
6. Tire inspection for proper inflation, defects, and wear <sup>1</sup>	6.82	7.30	7.18	5.90				
7. Testing a safety switch to detect malfunctions <sup>3</sup>	6.78	6.89	7.31	6.50				
8. Checking engine crankcase oil level <sup>1</sup>	6.68	7.29	7.93	5.43				
9. Servicing an oil cooler	6.58	6.58	6.81	6.55				
10. Shutting down a steam cleaner <sup>1</sup>	5.92	6.10	6.43	5.52				
11. Preparing a steam cleaner for use <sup>3</sup>	5.75	5.82	6.06	5.58				
12. Cleaning a tractor with a steam cleaner <sup>3</sup>	5.69	5.95	6.12	5.18				

\*Grade level to teach: 1 = ninth grade and 3 = eleventh grade.

Table 2

## MEAN COMPETENCE LEVEL STUDENTS SHOULD POSSESS FOR ELECTRICAL SYSTEM SKILLS

Skills	Composite Competence		Teacher Competence		Teacher Educator Competence		Service Rep Competence	
	Mean		Mean		Mean		Mean	
1. Setting ignition timing <sup>3*</sup>	7.70		7.92		8.43		7.20	
2. Replacing ignition points and condensers <sup>3</sup>	7.60		7.81		8.43		7.12	
3. Setting ignition points <sup>3</sup>	7.56		7.84		8.25		6.98	
4. Replacing a distributor <sup>3</sup>	7.44		7.44		7.75		7.41	
5. Cleaning and servicing a spark plug <sup>2</sup>	7.05		7.60		7.50		6.03	
6. Replacing a wiring harness <sup>3</sup>	6.94		6.72		7.12		7.30	
7. Cleaning battery terminals, cables and battery boxes <sup>1</sup>	6.88		7.41		7.93		5.80	
8. Replacing starter brushes <sup>3</sup>	6.84		6.62		6.81		7.22	
9. Testing an ignition switch <sup>3</sup>	6.79		6.70		7.00		6.91	
10. Tightening battery cables and battery hold down clamps <sup>1</sup>	6.75		7.25		7.87		5.69	
11. Testing a vacuum advance mechanism <sup>3</sup>	6.72		6.66		6.81		6.80	
12. Treating battery terminals to prevent corrosion <sup>1</sup>	6.67		7.24		7.75		5.50	
13. Measuring specific gravity of a battery using a hydrometer <sup>3</sup>	6.60		6.77		7.93		6.08	
14. Polarizing a generator <sup>3</sup>	6.54		6.20		7.43		6.97	

\*Grade level to teach: 1 = ninth grade, 2 = tenth grade, and 3 = eleventh grade.

Teachers and teacher educators indicated that ten of the electrical system skills should be taught at the eleventh-grade level, one at the tenth-grade level, and three at the ninth-grade level, as shown in Table 2.

The fourteen fuel and cooling systems skills judged by the panel as ones that should be taught in an agricultural production vocational agriculture program are listed in Table 3. The level of competence a student should possess upon graduation ranged from a high of 8.50 by teacher educators for "adjusting carburetor air/fuel mixture" to a low of 5.63 by machinery service representatives for "replacing a fan belt." Only four skills (numbers 10, 11, 13, and 14) had mean competence ratings below 6.0 on a 9-point scale. These ratings were by the agricultural machinery service representatives. The composite competence means ranged from a high of 7.55 for "bleeding a diesel fuel system" to a low of 6.56 for "replacing a radiator hose." The cooling system skill with the highest composite competence mean (6.91) was "testing radiator coolant with a hydrometer."

Teachers and teacher educators indicated that ten of the skills should be taught at the eleventh-grade level, three at the tenth-grade level, and one at the ninth-grade level, as shown in Table 3.

Table 4 presents the eleven tractor engine, power train, and drive skills which the panel of judges said should be taught in an agricultural production vocational agriculture program. The mean competence ratings show the level of competence vocational agriculture teachers, agricultural mechanics teacher educators, and agricultural machinery service representatives felt students should possess upon completion of the program. The highest competence mean (8.18) by teacher educators was observed for "adjusting engine idle speed." The lowest competence mean (5.59) was assigned by service representatives for "draining and refilling a differential." The composite means ranged from a high of 7.39 for "valve adjustment" to a low of 6.55 for "manual adjustment of wheel bearings."

Teachers and teacher educators indicated that nine of the skills should be taught at the eleventh-grade level, one at the tenth-grade level, and one at the ninth-grade level, as shown in Table 4.

### *Conclusions and Implications*

The study identified 51 agricultural tractor service skills that should be taught in a high school agricultural production program in the twelve-state U. S. central region. Vocational agriculture teachers, agricultural mechanics teacher educators, and agricultural machinery service representatives for Ford, Massey Ferguson, International Harvester, and John Deere in the twelve-state region indicated that students should have a rela-

Table 3

MEAN COMPETENCE LEVEL STUDENTS SHOULD POSSESS FOR FUEL AND COOLING SYSTEMS SKILLS

Skills	Composite	Teacher	Teacher	Service Rep
	Competence	Competence	Educator	Competence
	Mean	Mean	Competence	Mean
1. Bleeding a diesel fuel system <sup>3*</sup>	7.55	7.38	8.12	7.76
2. Adjusting carburetor air/fuel mixture <sup>3</sup>	7.47	7.63	8.50	7.02
3. Adjusting a carburetor float <sup>3</sup>	7.13	7.12	7.75	7.04
4. Servicing a fuel tank and fuel lines <sup>3</sup>	6.94	7.08	7.62	6.58
5. Testing radiator coolant with a hydrometer <sup>2</sup>	6.91	7.15	8.06	6.33
6. Testing a thermostat for proper functioning <sup>3</sup>	6.78	6.47	7.31	7.24
7. Testing for cooling leaks <sup>3</sup>	6.75	6.74	7.75	6.63
8. Replacing a water pump <sup>3</sup>	6.74	6.89	7.31	6.40
9. Replacing a fuel pump <sup>3</sup>	6.73	6.90	7.25	6.36
10. Replacing a thermostat <sup>3</sup>	6.71	7.06	7.81	5.95
11. Cleaning a settling bowl <sup>2</sup>	6.63	7.16	7.62	5.54
12. Flushing and cleaning a radiator <sup>3</sup>	6.65	6.91	7.43	6.07
13. Replacing a fan belt <sup>2</sup>	6.66	7.16	7.75	5.63
14. Replacing a radiator hose <sup>1</sup>	6.56	6.93	6.93	5.86

\*Grade level to teach: 1 = ninth grade, 2 = tenth grade, and 3 = eleventh grade.

Table 4

## MEAN COMPETENCE LEVEL STUDENTS SHOULD POSSESS FOR ENGINE, POWER TRAIN, AND DRIVE SKILLS

Skills	Composite	Teacher	Teacher	Service Rep
	Competence	Competence	Educator	Competence
	Mean	Mean	Mean	Mean
1. Valve adjustment <sup>3*</sup>	7.39	7.17	7.81	7.72
2. Adjusting engine idle speed <sup>3</sup>	7.25	7.53	8.18	6.64
3. Adjusting clutch free play <sup>3</sup>	7.17	7.10	7.93	6.46
4. Compression testing an engine <sup>3</sup>	7.15	7.08	8.12	7.13
5. Packing wheel bearings <sup>3</sup>	7.03	7.25	7.87	6.50
6. Changing hydraulic filters <sup>3</sup>	6.95	7.17	7.75	6.46
7. Draining and refilling a hydraulic system <sup>3</sup>	6.93	7.16	7.43	6.44
8. Servicing a universal joint <sup>3</sup>	6.87	6.92	7.06	6.76
9. Checking transmission and differential lubricant level <sup>1</sup>	6.78	7.37	7.68	5.62
10. Draining and refilling a differential <sup>2</sup>	6.56	7.04	7.43	5.59
11. Manual adjustment of wheel bearings <sup>3</sup>	6.55	6.59	7.50	6.34

\*Grade level to teach: 1 = ninth grade, 2 = tenth grade, and 3 = eleventh grade.

tively high level of competence (five or above on a nine-point competence scale) for each of the 51 skills. Teachers and teacher educators felt that 34 of the skills should be taught at the eleventh-grade level, five at the tenth-grade level, and 12 at the ninth-grade level.

The findings of this study have implications for agricultural mechanics instruction in high school agricultural production programs, for facilities and equipment for programs, and for preservice and inservice teacher education programs. Vocational agriculture teachers cannot be expected to teach tractor service skills unless they have the technical competencies themselves and the facilities and equipment with which to teach. Instruction in the service of tractors should not become extinct in a high school agricultural production vocational agriculture program. As tractors become more complex, the challenge grows even greater for students to develop tractor service skills. If vocational agriculture does not meet the challenge to provide relevant instruction in this area, some other program will emerge to meet the need.

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