PREPARATION OF PRE-SERVICE TEACHERS IN AGRICULTURAL MECHANICS

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Abstract

Teacher education programs face a myriad of challenges in preparing secondary agricultural education teachers. One challenge is providing preparation in technical content areas including agricultural mechanics. The purpose of this study was to determine the level of preparedness of agriculture teacher education program graduates in the area of agricultural mechanics. The target population for the study was certifying institutions for agricultural education teachers in the United States. Data were collected with a mailed questionnaire sent in the fall of 2003. A total of 69 completed surveys were returned for a response rate of 78.4%. More than 90% of respondents indicated that six of the nine content areas were included in their state's secondary curriculum. Respondents identified the level of importance as "important" for each of nine competency groupings. Respondents identified the level of preparation for hand/power tools as "prepared." The remaining eight competency groupings were rated as "somewhat prepared." More than 97% of respondents indicated that some agricultural mechanics credits were required for program completion. The average number of credits required for program completion was 9.13. A majority (58%) of institutions indicated that at least one required course was taught within the department housing the teacher preparation program.

Introduction/Theoretical Framework

Teacher education programs face a myriad of challenges in preparing secondary agricultural education teachers. One such challenge is providing adequate preparation in technical content areas. Connors and Mundt (2001) found that institutions require an average of 128 hours for graduation. Only 45 hours on average were dedicated to technical content. Approaches used to meet this challenge are varied. McLean and Camp (2000) concluded that it is impossible to establish a typical set of courses commonly taught in teacher preparation programs. Given this conclusion, is there consistency to the level of preparation of beginning teachers between programs?

This problem only becomes more complicated when considering a particular content area. Agricultural mechanics has traditionally been a cornerstone in the secondary program. Previous studies have identified the importance of agricultural mechanics. Kotrlik and Drueckhammer (1987) found that agricultural mechanics, along with supervised occupational experience programs, were the two most important components in ensuring quality programs in the future. Laird and Kahler (1995) recommended that agricultural mechanics instruction should continue to be included in secondary agriculture programs. In a study of the role of agricultural mechanics in secondary agricultural education, Rosencrans and Martin (1997) found that a majority (69%) of participating secondary teachers believed that stand alone courses in agricultural mechanics were critical components of agricultural education programs.

In addition, student interest in agricultural mechanics remains strong as well. The Missouri Department of Elementary and Secondary Education (DESE) (2003) identified agricultural

mechanics courses as the highest area of enrollment among secondary agriculture classes. Additionally, agricultural mechanics was identified as the highest rated student interest area.

Recent changes in university level agricultural mechanization programs have forced teacher educators to evaluate the role of agricultural mechanics in a new light. Harrison, Schumacher, and Birkenholz (1993) indicated that these programs were experiencing a decline in student enrollment combined with a decrease in financial support. Previous studies have focused on the importance of integrating math and science into the agricultural mechanics curriculum. Harper, Buriak, and Hilton (1995) concluded that, with an emphasis on science-based agricultural education, the competency format of agricultural mechanics is less useful. They further concluded that competency based guidelines are "too extensive to be met by prospective teachers given the reduction in credit requirements in agriculture" (Harper et al., p. 480). Rosencrans and Martin (1997) found that the majority of instructors in their study agreed that courses in agricultural mechanization should be science-based, applied physics with applications in agriculture. They further recommended that instructors develop instructional materials utilizing the systems approach, problem-solving and critical thinking skills and develop ways to integrate the agricultural technology curriculum within other curricular areas. While this approach is both valid and supported, the argument lies in the technical competence required by teachers to apply this integrated approach.

Rosencrans and Martin (1997) proposed the Curriculum Model for Agriculture Technology Education (CMATE). The CMATE (Figure 1) was constructed around the student in agricultural technology education and focuses on the delivery systems utilized in those courses. Additionally, the model identified eight distinctive components to be included in courses, the first of which was basic and general knowledge and skills about agricultural technology. Although Rosencrans and Martin made no efforts to distinguish these in a hierarchical context, it is logical that these basic skills are important in that they provide the mechanism for other components to be included.

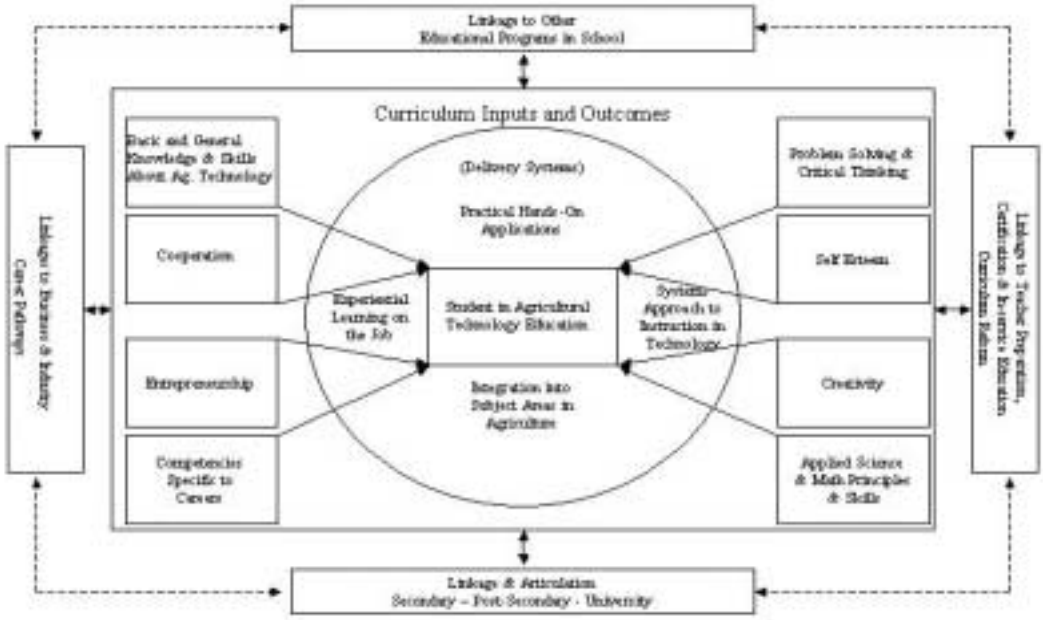

Figure 1. Curriculum Model for Agriculture Technology Education
Note. From "The role of agricultural mechanization in the secondary agricultural education curriculum as viewed by agricultural educators" by C. Rosencrans Jr. and R. A. Martin, 1997, *Proceedings of the 24th Annual National Agricultural Education Research Meeting.* Reprinted with permission.

While the competency approach to teaching agricultural mechanics in secondary programs has drawn criticism as an instructional methodology, the competency of the instructor in those mechanical skills remains important. The CMATE model suggests components that are important in agricultural mechanics instruction at the secondary level. In doing so, the model also serves as a framework from which we can investigate the preparation of teachers in each of these areas.

Teacher educators, as a group, have further identified the importance of the development of agricultural mechanics competencies in pre-service teachers. Standard two of the AAAE National Standards for Teacher Education in Agriculture states: "The design of the agricultural education teacher preparation program ensures that students complete a balanced program of general education, technical content, and pedagogical and professional studies" (AAAE, 2002). Sub-standard 2b specifically calls for programs to be designed so that "candidates obtain competence in basic principles, concepts and experiential practices in agricultural science and natural resources related to (B) agricultural and mechanical systems" (AAAE). The inclusion of agricultural mechanics competencies in these standards underscores the importance that this area has on secondary agricultural programs.

If agricultural mechanics is to remain a vital part of secondary programs, certainly the delivery systems in which these courses are applied is critical. However, regardless of the approach taken by agriculture teachers, the success of those courses depends upon the instructor's ability to first master those competencies in

agricultural mechanics. Are teacher education programs adequately preparing program graduates in agricultural mechanics?

Purpose/Objectives

The purpose of this study was to determine the level of preparedness of program graduates in the area of agricultural mechanics. The following research objectives were developed to guide the study.

1. Determine if selected agricultural mechanics content areas are included in the secondary curriculum.
2. Identify the perceived level of importance of agricultural mechanics content areas for program graduates.
3. Identify the perceived level of preparation for program graduates in agricultural mechanics content areas.
4. Describe characteristics related to instruction in agricultural mechanics.

Methods/Procedures

This research was descriptive in design and sought to establish baseline data for identifying the competencies that are important to teacher education programs in regard to agricultural mechanics. Furthermore, this study sought to identify the methods employed by institutions to satisfy those competency requirements.

The target population for the study was all certifying institutions for agricultural education teachers in the United States. A list of certifying institutions was obtained from the American Association of Agricultural Educators directory of University Faculty in Agricultural Education (Dyer, 2002). Frame error was controlled by reviewing the list with teacher educators to determine if any institution was missing or should not be sent a survey instrument. The researchers, along with a panel of experts, identified one person at each institution to receive the survey. The resulting target population was equal to 88 institutions. A census was conducted due to the small number of institutions in the target population.

Data were collected according to Dillman's (2000) tailored design method. The instrument, cover letter, and return envelope were mailed to participants in the fall of 2003. An email reminder was sent to participants two weeks after the initial mailing. A second mailing, containing the instrument and revised cover letter, was sent two weeks after the email reminder. A total of 69 completed surveys were returned for a response rate of 78.4%. The result was an accepting sample of 69. Findings of this study are only characteristic of the accepting sample. Caution should be used in generalizing to larger populations.

A questionnaire, developed by the researchers, was used to collect data. The questionnaire contained four parts. Part one identified content areas within agricultural mechanics. Participants were asked to respond "yes" or "no" to each content area indicating the presence of that area in current secondary programs in their respective states. The second part of the questionnaire was used to address objectives two and three. For each content area, a list of representative competencies was developed by the researchers using existing curriculum from several states. For each individual competency, participants were asked to rate their perception of the importance of that competency on a Likert-type scale ranging from 1 = not important to 5 = very important. Additionally, participants also indicated their perception of the level of preparation for the program graduates in regard to those individual competencies. Again, participants were asked to rate their perception of the level of preparedness of their program graduates on a Likert-type scale ranging from 1 = not prepared to 5 = very prepared for each of those competencies. Composite means were used to represent the level of importance and the level of preparation for each content area. Part three of the instrument contained six questions that sought to identify program characteristics related to instruction in agricultural mechanics.

The instrument was reviewed for content and face validity by a panel of experts consisting of teacher educators in agricultural education at the University of Missouri and practicing secondary

agriculture teachers. Post-hoc reliability yielded Cronbach's alphas ranging from .74 to .92 for the items dealing with importance. For items related to level of preparedness, Cronbach's alphas ranged from .88 to .96. Descriptive statistics were used to analyze the data using SPSS v. 11.5. Frequencies, means and standard deviations were used to report the findings.

Results/Findings

For objective one, participants were asked to identify if the agricultural mechanics content area was included in the secondary program curriculum in their state. Figure 2 displays the percentages of responses. Of the nine content areas identified, more than 90% of respondents indicated that six areas were included in their respective state's secondary curriculum. Those areas were metal fabrication, hand/power tools, project planning and materials selection, electricity, and building construction. More than 98 % of the respondents indicated that electricity was included in their state's secondary curriculum. Plumbing, concrete, and machinery and equipment were identified by more than 80% of the respondents as included in secondary programs.

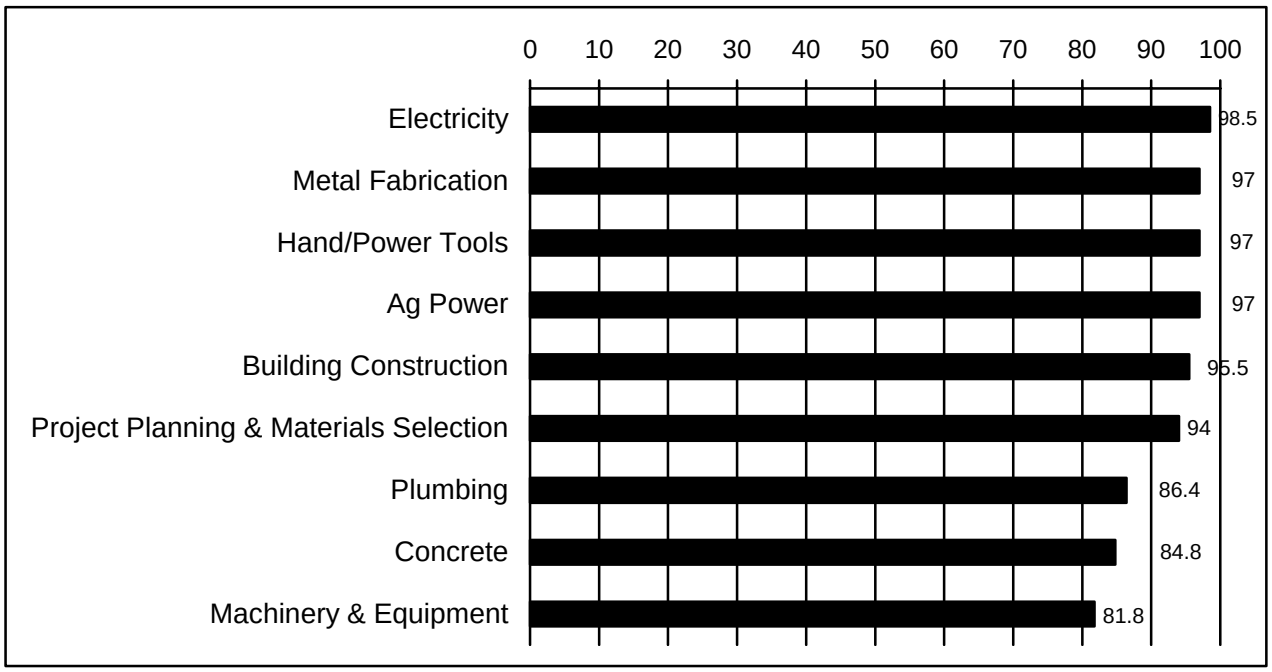

Figure 2. Percentage of Respondents Indicating Inclusion in State Secondary Programs

Objective two sought to identify the perceived level of importance of categorized agricultural mechanics competencies. Participants were asked to identify the importance level for fifty-three individual agricultural mechanics competencies. Competencies were grouped according to content areas. Composite means were used to report a composite score for each content area. Table 1 shows the means and standard deviations for each of those competency groupings. Respondents identified the level of importance as "important" for each of the nine competency groupings. Hand/Power tools had the highest mean value for importance followed by Ag Power. Conversely, Plumbing and Machinery and Equipment had the lowest mean values.

Table 1
Mean Level of Perceived Importance for Competency Groupings

Competency Grouping	*M*	*SD*
Hand/Power Tools	4.21	.62
Ag Power	4.11	.70
Electricity	3.98	.70
Project Planning and Materials Selection	3.76	.63
Metal Fabrication	3.72	.70
Building/Construction	3.89	.69
Concrete	3.70	.85
Machinery and Equipment	3.56	.75
Plumbing	3.53	.93

Note.1 = Not Important, 2 = Of Little Importance, 3 = Somewhat Important, 4 = Important, 5 = Very Important.

In response to objective three, participants were asked to identify their perception of the level of preparation of their program graduates with regards to those fifty-three individual agricultural mechanics competencies. Competencies were grouped according to content areas. Composite means were used to report a composite score for each content area.

Table 2 displays the means and standard deviations for each of those competency groups. The highest composite mean was reported for hand/power tools (3.51) indicating "prepared." Seven of the remaining eight competency groupings had an overall rating of "somewhat prepared" with mean values ranging from 2.65 to 3.42. Those were ag power, metal fabrication, electricity, building/construction, project planning and material selection, concrete, and plumbing. In contrast, machinery and equipment was identified as "poorly prepared" (2.35).

Table 2
Perceived Level of Preparation for Competency Groupings

Competency Grouping	*M*	*SD*
Hand/Power Tools	3.51	0.95
Ag Power	3.42	1.19
Metal Fabrication	3.17	0.98
Electricity	3.13	1.08
Building/Construction	3.01	1.04
Project Planning and Materials Selection	2.90	0.91
Concrete	2.85	1.20
Plumbing	2.65	1.13
Machinery and Equipment	2.35	1.04

Note. 1=Not Prepared, 2=Poorly Prepared, 3=Somewhat Prepared, 4=Prepared, 5=Very Prepared.

Objective four sought to describe program characteristics related to agricultural mechanics. Question one asked respondents to identify if their state specifically required agricultural mechanics credits for teacher certification. Of the 46 states with teacher preparation programs, the accepting sample represented 37 states. Figure 3 illustrates the agricultural mechanics requirements for certification. Twenty-six states indicated that some agricultural mechanics credits were required for certification. Eleven states had no requirement for agricultural mechanics.

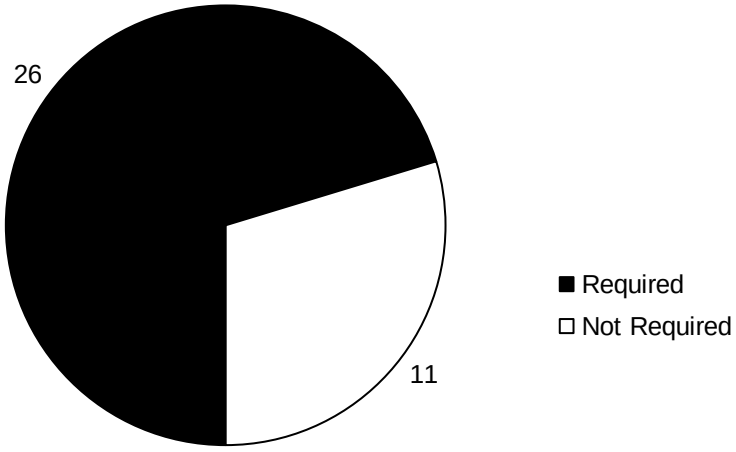

Figure 3. Number of States Requiring Credits in Agricultural Mechanics (*n* = 37)

Question four of the instrument asked respondents to identify the number and types of courses required for program completion at their respective institution. Table 3 shows the agricultural mechanics credits required for program completion. Over 97 percent of respondents indicated that some agricultural mechanics credits were required for program completion. Only two institutions (2.9%) required no credits in agricultural mechanics. The modal category was 5 to 8 credits required as indicated by over 38 percent of the respondents.

Table 3
Number of Agricultural Mechanics Credits Required for Program Completion (N = 69)

Required Semester Credits	*f*	*%*
0	2	2.90
1 to 4	5	7.25
5 to 8	26	38.69
9 to 12	23	33.34
13 to 16	10	14.50
17 to 20	3	5.80

Additionally, respondents were asked to identify the specific courses required for program completion. Courses were classified into content areas according to the course title. Table 4 summarizes the frequency with which content specific courses were required. Forty-two of the respondents identified a general agricultural mechanics course as a completion requirement. Slightly over 50% (35) indicated that courses in engines and/or power and machinery were required in their department. Only 10% (7) required a course focusing specifically on electricity.

Table 4
Types of Agricultural Mechanics Courses Required for Program Completion (N = 69)

Course Type	*f*	%
General Ag Mechanics	42	60.87
Engines/Power and Machinery	36	52.17
Metal Fabrication	31	44.93
Methods	26	37.68
Ag Structures	22	31.88
Other[a]	14	20.28
Electricity	7	10.14

Note. Some institutions required courses in more than one content area.
[a]Other includes surveying, irrigation, safety, global positioning, and computer applications.

Participants were asked to identify which departments offer their required courses in agricultural mechanics. Those departments were categorized according to title. Table 5 shows the types of departments that offer those required courses. A majority (58%) of institutions indicated that at least one of the required courses was taught within the department housing the teacher preparation program. Nearly 40% (27) of respondents indicated that at least one course was taught outside of their home department and within the institution's agriculture college. Only four (4%) programs reported that a required course was taught in a department other than an agricultural department and less than two percent (2) reported that required credits were earned outside of their institution.

Table 5
Department Offering Required Courses in Agricultural Mechanics

Course Location	*f*	%
Home Department	40	57.97
Other Agricultural Department	27	39.13
Department other than Agriculture	4	4.35
Outside of the institution	2	1.45

Note. Some institutions required courses from more than one department.

Conclusions/Recommendations/ Implications

Objective One: Determine if selected agricultural mechanics content areas are included in the secondary curriculum.

While one of the strengths of the secondary agricultural education program is the flexibility to create a curriculum based on the needs of the community, the findings of this study indicate that agricultural mechanics is representative of those needs and is still a valuable part of the secondary agricultural curriculum. The variety of content areas included in secondary programs indicates that agricultural mechanics is a broad area of study and cannot be constricted to one or two specific areas. The magnitude of this impact can be measured by the number of respondents indicating the presence of the various agricultural mechanics content areas in secondary programs.

An overwhelming majority of respondents indicated that those content areas in agricultural mechanics identified were still part of the secondary agriculture program. This can be seen through secondary enrollments. Each year, Missouri's Department of Elementary and Secondary Education (DESE) collects information regarding secondary agricultural education programs. The DESE (2003) reported that agricultural mechanics courses had the highest enrollment in agricultural education programs in 2002. In addition to enrollment, the highest rated student interest area in Missouri was agricultural mechanics (DESE).

Objective Two: Identify the perceived level of importance of agricultural mechanics content areas for program graduates.

Teacher educators perceive each of the nine areas of agricultural mechanics to be important. Furthermore, low standard deviations indicate that teacher educators are in agreement on the level of importance. This view is consistent with previous studies (Kotrlik & Drueckhammer, 1987; Laird & Kahler, 1995; Rosencrans & Martin, 1997) identifying agricultural mechanics as a vital part of secondary agriculture programs.

The perception of importance by teacher educators further implicates the need for adequate preparation of pre-service teachers in agricultural mechanics. Pre-service teachers will benefit from programs that offer experiences in a wide range of agricultural mechanics content areas.

Harrison et al. (1993) stated that agricultural mechanization programs at the post-secondary level were facing declining enrollments and program closures. Institutions are likely to be continually challenged to provide adequate instruction in agricultural mechanics. As states continue to dedicate a large part of their secondary curriculum to agricultural mechanics, so should teacher preparation institutions continue to dedicate part of their degree programs to developing teacher competencies in these areas.

Future studies are needed to determine relevant content in agricultural mechanics in secondary programs. Previous studies (Polson, 1985, and Harrison et al., 1993) investigated agricultural mechanics competencies that should be included in secondary programs. This effort should be a continual process to ensure that agricultural competencies taught at the secondary level are an adequate reflection of those important to the agricultural industry. Additionally, more focus should be directed to identify newly emerging competencies in this field.

Objective Three: Identify the perceived level of preparation for program graduates in agricultural mechanics content areas.

Teacher educators rated the level of preparation in agricultural mechanics of program graduates lower than the level of importance of competencies in that area. Respondents indicated that their program graduates were somewhat prepared in all content areas with the exception of hand and power tools, in which they were prepared, and machinery and equipment, in which they were poorly prepared. In contrast to the level of importance, standard deviations indicate less agreement among teacher educators on level of preparation of the content areas.

Metal fabrication was identified as the fifth most important content area. However,

metal fabrication ranked third with regard to level of preparation. This suggests inconsistencies in the allocation of resources to prepare program graduates. Agricultural mechanics instruction is closely dependent upon available resources. Students are possibly receiving instruction in those content areas in which there are resources to teach without concern for the level of importance of skill development in that content area.

The discrepancy between importance and level of preparation underscores the fact that teacher educators must continue to include agricultural mechanics in their teacher preparation programs. However, additional steps must be taken to identify effective strategies for providing preparation in the areas most important. Replicating this study among secondary teachers may provide more insight into the level of importance of agricultural mechanics at the secondary level.

Objective Four: Describe characteristics related to instruction in agricultural mechanics.

As agricultural mechanics programs face declining enrollments and programmatic changes (Harrison et al., 1993), new challenges arise for teacher preparation programs. Results of this study indicate almost 60% of institutions reported that agricultural mechanics classes were taught within the department housing the teacher preparation program. Agricultural education programs are taking on more of the responsibility for offering agricultural mechanics courses. While some agricultural education departments have traditionally held that role, other institutions need to be prepared to assume that role. To adequately address this concern, further investigation is needed into teacher development. Where and how are teachers developing these competencies outside of their teacher preparation program? Research in this area may uncover additional opportunities to further prepare teachers through in-service training, workshops, or possibly unique cooperative partnership opportunities.

Connors and Mundt (2001) found that the average credit requirement for technical agriculture was 43.4. Findings of the current study indicated the average number of credits required by institutions in agricultural mechanics was 9.13. According to these findings, only a small percent of technical agricultural credits are dedicated to agricultural mechanics. More than 60% of the respondents indicated that a general agricultural mechanics course was required for program completion. Institutions are taking a more general approach in place of content specific courses. More than 98% of the respondents indicated that electricity was included in their states curriculum. However, only 10% of programs require a content specific electricity course.

Furthermore, 97% of the respondents indicated that metal fabrication was included in the secondary curriculum. Respondents also noted that metal fabrication was an important content area. However, only 45% of teacher preparation programs offer courses in metal fabrication. Therefore, it is recommended that more teacher preparation programs offer courses in electricity and metal fabrication in order to properly prepare future teachers for secondary agricultural education.

The need exists to structure teacher education programs to more adequately prepare graduates in agricultural mechanics. Findings of this study support the conclusions made by McClean and Camp (2000) indicating the difficulty in establishing a typical set of courses for teacher education programs. Increasing credit requirements in other areas and limited availability of courses may force agricultural education programs to develop creative and innovative solutions to ensure that program graduates, as well as practicing teachers, are given the opportunity to develop technical competencies in the field of agricultural mechanics. To meet this charge, institutions will have to look beyond traditional outlets for preparation. Possible alternatives might include developing partnerships with technical schools, developing in-service programs, or developing corporate partners.

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