Preparing Pre-service Agricultural Education Teachers to Teach Agricultural Mechanics: Are We Doing Enough?

Abstract

Agricultural mechanics is a technical skill area that poses numerous challenges for teacher preparation programs due to safety, time needed to learn technical skills, and credit hour requirements. The skills required to manage a laboratory are crucial for instructors of agricultural mechanics curriculum. Agricultural mechanics is a popular course in secondary schools, but studies found that pre-service teachers were ill-equipped to teach the courses effectively. Determining the level of readiness of graduates of teacher preparation programs to teach agricultural mechanics was the purpose of this study. Certifying institutions for agricultural education teachers across the nation comprised our target population. A questionnaire was used to collect data for this study, resulting in 48% response rate (n = 52). Of the nine agricultural mechanics curriculum content areas most teachers reported they had five in their state curriculum. The nine content areas were determined to be "Important" by the teachers in this study. Hand/Power Tools (M = 3.69) was the only content area that institutions ranked their graduates as "Prepared" to teach. The remaining content areas were ranked as "Somewhat" or "Poorly" prepared. Most institutions stated that they required at least one course in agricultural mechanics in their program, with the average requirement being five to eight hours. It can be concluded that agricultural mechanics course requirements have decreased since 2005, even though the content is heavily taught at the secondary level. This study has shown that we must re-evaluate how we prepare students to be competent to teach agricultural mechanics.

Keywords: mechanics; laboratory; pre-service; teacher education; preparation

Introduction

Agricultural mechanics is a significant component in agricultural education, but according to various studies, pre-service teachers are ill-equipped to teach the popular courses effectively (Burris et al., 2005; Shultz et al., 2014; Wells et al., 2021; Whitehair et al., 2020). School based agricultural education (SBAE) teachers are responsible for not only running the agricultural mechanics facilities, but also for preparing students for current opportunities in the agricultural industry (McCubbins et al., 2017; Phipps et al., 2008; Stringfield & Stone, 2017). Agricultural mechanics facilities offer the opportunity for hands-on teaching and learning in agricultural mechanics courses, which can encompass a variety of topics including machine and facility safety, small engines, carpentry and woodworking, welding and metal fabrication, electricity, maintaining power systems, laboratory management and more (Albritton & Roberts, 2020; Burris et al., 2005; Hainline & Wells, 2019; Saucier et al., 2014a; Shultz et al., 2014).

Agricultural mechanics courses are generally taught within many secondary and post-secondary agricultural education programs (Burris et al., 2005; Phipps et al., 2008) and tend to be highly sought after for many students (Valdez & Johnson, 2020). A majority of agricultural educators teach at least one agricultural mechanics course (Burris et al., 2005). Previous researchers have recommended that agricultural mechanics content should be included in teacher preparation degree programs due to the lack of knowledge possessed by pre-service teachers (Saucier & McKim, 2011). Though agricultural mechanics is widespread at the secondary level, many teacher preparation programs fail to engage their students in agricultural mechanics courses (Swafford &

Hagler, 2018). If agricultural mechanics is taught in SBAE and preservice teachers supposedly take courses in mechanics during their pre-service teacher training, where is the disconnect?

Pre- and In-service teachers tend to form anxiety towards working and running their agricultural mechanics facilities (Tummons et al., 2017). These feelings can be related to lack of subject matter knowledge, liability issues, student supervision, laboratory management, low self-efficacy and more (Hainline et al., 2019; Tummons et al., 2017). Some pre- or in-service teachers are also expected to engage in laboratory facility design and layout, instructional planning, safety planning, and more, all of which they feel that they are not prepared to do (Whitehair et al., 2020). Some preservice teachers have been given a limited experience or exposure in agricultural mechanics and/or have had negative experiences in the curriculum area (Tummons et al., 2017). One study showed that less than 50% of their pre-service teacher preparation programs offered a metal fabrication course when over 95% of teachers rated it as important (Burris et al., 2005). Data such as this suggests that teacher preparation programs are not sufficiently preparing their graduate to be successful in teaching agricultural mechanics courses.

Preparing SBAE teachers is a task of unending challenges. One of these challenges is providing enough preparation in technical skill areas. Connors and Mundt (2001) found that an average of only 45 hours of specific agricultural content was required by teacher preparation programs. Burris et al. (2005), reported that the national average for agricultural mechanics credits reported by institutions ranged from zero hours to twenty hours, with the majority of universities having an average of five to eight credits dedicated specifically to agricultural mechanics. Saucier and McKim (2011) discovered that of the ten departments of agricultural education in ten Western states, only half of the program curriculums provided three or more classes in agricultural mechanics for Agricultural Education teacher certification. One study by Byrd et al. (2015), that observed completion of post-secondary agricultural mechanics coursework and its effect on teacher competency revealed that of their agricultural education participants, the highest percentage (34.95%, n = 36) had no post-secondary background related to agricultural mechanics. Of the participants, slightly over 29% (n = 30) indicated that they completed only one college course. The other 35.92% (n = 37) of teachers had ranged between two and thirteen agricultural mechanics courses completed (Byrd et al., 2015).

To be effective agricultural mechanics teachers, individuals should possess both theoretical and technical knowledge. Universities often fail to have their pre-service agricultural educators take more than one agricultural mechanic's class, if any at all. Teachers who are unprepared in agricultural mechanics cannot possibly offer the best agricultural mechanics experience to their future students (Byrd et al., 2015; Swafford & Hagler, 2018).

Even when pre-service teachers may have adequate agricultural mechanics experience, many do not perceive themselves to be prepared to teach that content in a classroom. They do not feel comfortable with their own ability to perform skills such as welding, and this uncertainty in themselves transfers to their uncertainty in a level of mastery high enough to convey this information to students (Blackburn et al., 2015). Tummons et al. (2017) found that many pre-service teachers had concerns about their ability to lead agricultural mechanics classrooms while trying to reduce liability issues. Teacher knowledge is varied and is a crucial component for the development of successful teachers so that they may create impactful and memorable experiences for others (Malm, 2009). Teacher competence is essential to ensure a safe, effective, and positive agricultural mechanics learning opportunities for students (Albritton & Roberts, 2020; Byrd et al., 2015; Hainline & Wells, 2019; Shultz et al., 2014; Swafford & Hagler, 2018). Further compounding the issue in Texas, females made up the majority (55%) of student teachers who completed less than ten credit hours of agricultural mechanics coursework magnifying the issue as the percentage of female pre-service teachers in on the rise (Saucier & McKim, 2011). Recently, females have been observed as feeling less comfortable in an agricultural mechanics laboratory. The concerns of female teachers not only include skill inadequacy, but expanded to include concern for personal safety, judging trustworthiness of students, and coping with low-trust students (Tummons et al., 2017).

Safety is a significant need of all agricultural mechanics teachers, and it is a vital piece of each course. However, many teachers do not feel as though their classroom or laboratory is as safe as it can be, and they desire more professional development in that area (Saucier et al., 2014b). Ensuring future educators have the opportunities to achieve proficient mastery of agricultural mechanics content will create a positive impact in their experience, motivation, attitude and management when teaching agricultural mechanics contents (Saucier & Krysher, 2014).

Other challenges that educators face may be a lack of funding and poor materials, having their classes considered less important, and/or the lack of dedication of their students, all of which factor into the challenges that studies are seeing (McCubbins et al., 2016). These circumstances can be a driving force behind the low retention rate of agricultural educators (Smith et al., 2021). Some schools have been driven to the point of removing agricultural education from their offerings, something that is detrimental to not only the students at that school, but damages one of the largest industries in the United States (McCubbins et al., 2016). Increasing competency in subject matter along with receiving school support are two of many solutions to increase teacher retention (Elliott et al., 2017). Applying these concepts directly in agricultural mechanics can greatly improve teacher experience, especially when considering pre-service teachers' perceptions of what entering the profession looks like.

Agricultural mechanics is not only a beneficial class for students to learn applicable skills and prepare to enter the workforce, but also an opportunity for students to engage in scientific inquiry and problem solving. Students must assess problems, use theory to develop solutions, and execute their decision while in a safe learning environment (Saucier et al., 2012). Because of this, it is important to ensure that students will have access to agricultural mechanics classes for years to come; however, with this comes the struggle of training educators to adequately teach agricultural mechanics. The purpose of this study is to review training of preservice teachers in agricultural education and offer recommendations for the future of agricultural mechanics in post-secondary agricultural education teacher preparation programs.

Theoretical Framework

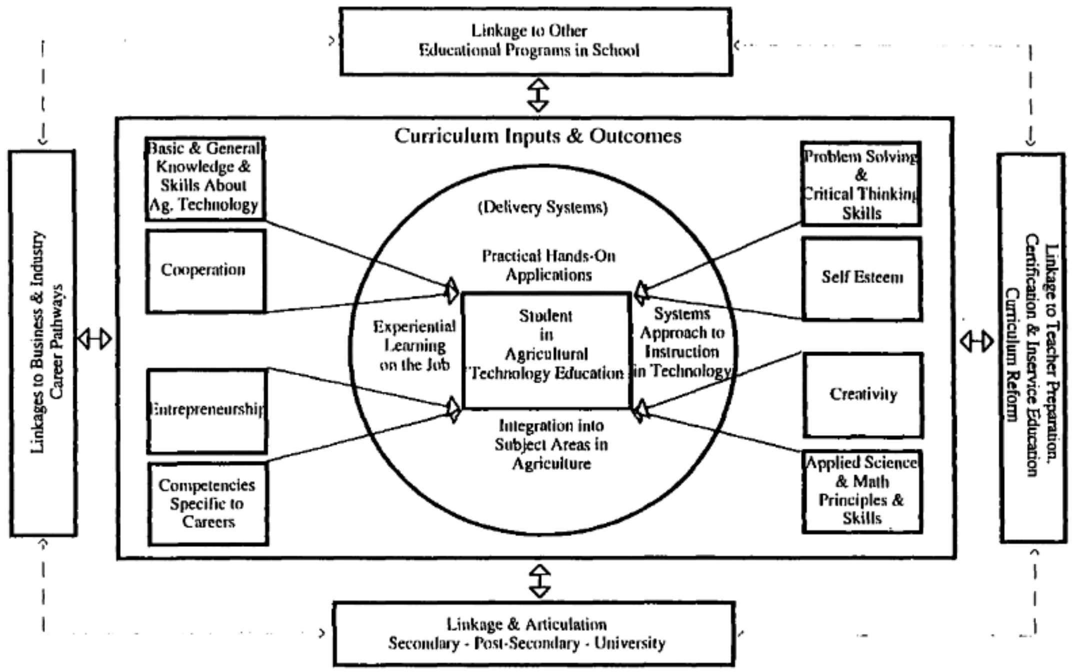
Rosencrans (1996), later with the help of Martin et al., (1997) designed a practical curriculum model to be used in agricultural mechanization areas within agricultural education programs. The model created is known as the Curriculum Model for Agricultural Technology Education (CMATE) and is presented in Figure 1 (Rosencrans, 1996; Rosencrans & Martin 1997). The CMATE was established to guide the delivery of content in courses that taught agricultural technology (Rosencrans & Martin 1997). However, it should be noted that Rosencrans (1996) did not use the term agricultural mechanization due to the era when previous studies indicating that agricultural technology (Eighmy, 1995; Shinn, 1995) suggested that a more contemporary description would provide a positive light to agricultural "mechanics". By using the term "technology", the model would be more inclusive than "mechanics". For this study, we will focus on Basic and General Knowledge and Skills About Agricultural Technology, Practical Hands-On Applications and Experiential Learning on the Job aspects of the model portions of the CMATE model (Rosencrans & Martin, 1997). Although Rosencrans and Martin (1997) believed that these basic skills are crucial because they provide the means for other components to be incorporated.

The first component in Rosencrans's (1996) model is Practical Hands-On Applications, where teachers use real-world applications to give students realistic learning opportunities. Implications of this component in a class setting may be identified as designing and constructing relevant projects, such as a shed, fence, or demonstration models of similar items. The second component of the model, Experiential Learning on the Job, builds upon the practical real-world opportunities (Rosencrans, 1996). However, Rosencrans (1996) noted that the instructor would need to simulate an "on the job" environment for this component to work. Situations where this component may arise in a class setting may be replacing parts on the school's tractor to simulate a mechanic's shop, or working together to adjust the greenhouse irrigation system in order to keep the plants viable so they may be sold to the community. For this model to work efficiently, the curriculum and student outcomes need to include as many of the four components as functionally possible (Rosencrans, 1996). Although, for this study, the Practical Hands-On Applications, and the Experiential Learning on the Job areas serve as our theoretical underpinning. The Curriculum Inputs and Outcomes' area encompasses eight distinctive components of the curriculum that should be incorporated into each subject area (Rosencrans, 1996). For this study, Basic and General Knowledge and Skills About Agricultural Technology portion of the CMATE model (Rosencrans & Martin, 1997) will serve as the primary focus. This component involves instruction of a variety of information related to the agricultural technology sector (Rosencrans, 1996). Rosencrans (1996) believed that the providing agricultural technology learning opportunities and showing how they relate to other dimensions of agriculture helps develop student awareness. Rosencrans (1996) stated that eighty-six percent of the respondents from this study agreed that instruction in agricultural mechanization should narrow in on developing general knowledge and skills that may be transferable to a wide range of career fields.

Previously, the capacity of the instructor remains important to implementing agricultural mechanics because previous instructional methodologies such as the competency approach has drawn criticism, (Rosencrans & Martin 1997). Rosencrans and Martin (1997) believed that the CMATE model components could serve as a framework that can be used to investigate the preparation and competencies of SBAE pre-service and in-service teachers in each of the areas. Agricultural mechanics must remain a vital component of SBAE programs, but to be successful in delivering the content in these courses, the instructor must master the competencies in agricultural mechanics.

Figure 1.

Curriculum Model for Agricultural Technology Education (CMATE)



Purpose and Objectives

This study sought to compare the current level of importance and preparation of preservice teachers in agricultural mechanics between 2005 and 2021. The AAAE National Standards for Teacher Education in Agriculture, standard two relates to technical content knowledge (AAAE, 2017). Sub-standard 2.A. f. specifically calls for candidates to "possess knowledge and skills to operate equipment in Agricultural Education facilities" (AAAE, 2017, p. 2). Substandard 2.B.c. states that candidates must "exhibit knowledge of agricultural equipment found in facilities" (AAAE, 2017, p. 2). To guide this study the following objectives were used:

1. Compare selected agricultural mechanics curricular content areas from 2005 and 2021.
2. Compare the perceived level of importance of post-secondary SBAE teacher preparation program agricultural mechanics faculty from 2005 and 2021.
3. Compare the perceived level of preparation of post-secondary SBAE teacher preparation program agricultural mechanics faculty from 2005 and 2021.
4. Describe programmatic characteristics of agricultural mechanics instruction at post-secondary SBAE teacher preparation programs.

Methods

This descriptive study was a replication of the Burris et al, (2005) study examining the requirements of agricultural mechanics in post-secondary agricultural education teacher preparation programs. The original survey was obtained from the authors and was modified to include answer options that are applicable for today's agricultural education teacher preparation programs.

The target audience was a census of all the agricultural education teacher preparation programs in the nation (*N*=110) based on the indicated institutions from the American Association for Agricultural Education website (AAAE, 2021). From this list of institution, the researchers identified a representative from each institution that was either the agricultural mechanic instructor, faculty member of the teacher preparation program, or department head. If the individual was not the agricultural mechanics instructor they were asked to forward the email to the instructor of their agricultural mechanics courses.

The original survey was converted into a digital format online in Qualtrics. The agricultural mechanics related questions included in the survey helped identify content areas that were taught, their perceptions of the importance of content areas, level of student preparation, the required number of courses for their program, and what department were the courses aught. The survey examined nine curriculum areas within agricultural mechanics including: metal fabrication, hand/power tools, electricity, ag power, building construction, project planning & materials selection, plumbing, concrete, and machinery & equipment (Burris et al., 2005). A Likert-type scale was used for the questions related to importance 1 (not important) – 5 (very important), and level of preparation were 1 (not prepared) – 5 (very prepared).

The electronic survey was sent out following Dillman's Tailored Design Method to increase survey response and data quality (Dillman et al., 2014). Participants received an initial email with an invitation to complete the survey and then received three follow up emails in two-week increments. After all surveys were collected, we had a total of n = 52 usable instruments yielding a 47% response rate. The collected survey data was analyzed using IBM SPSS Statistics 27. Descriptive statistics were calculated, which included frequencies, means, percentages, and standard deviation to report findings from the survey. Burris et al., (2005) reported the survey's post-hoc reliability for importance ranged from .74-.92 and .88-.96 for level of preparedness. The post-hoc reliability for this study found similar scores.

Results

Table 1 displays the percentages of responses that relate to the inclusion of competency groups in their state secondary programs. Of the nine agricultural mechanics curriculum content areas most teachers reported they had five in their state curriculum, as opposed to the original study in which six areas were identified (Burris et al., 2005). Those areas were Ag Power, Hand/Power Tools, Metal Fabrication, Project Planning and Materials Selection, and Electricity. Just over 98% of the respondents indicated that Ag power was included in their state's secondary curriculum, unlike Burris et al.'s (2005) study that had Electricity as the competency area seen in most states. Building Construction and Machinery and Equipment were ranked in the low 80% range according to respondents. Finally, Concrete and Plumbing were recorded by respondents as 76.9% and 73.7% in relation to being included in their secondary programs. Building Construction and Plumbing had the most significant change from 2005 to 2021, resulting in a -12.8% and -12.7%, respectively.

Table 1

Percentage of Respondents Indicating Inclusion in State Secondary Programs by Competency Group

Content Area	2005* %	2021** %	Δ%***
Electricity	98.5%	94.1%	-4.4%
Metal Fabrication	97%	96.2%	-0.8%
Hand/Power Tools	97%	96.2%	-0.8%
Ag Power	97%	98.1%	+1.1%
Building Construction	95.5%	82.7%	-12.8%

Project Planning & Materials Selection	94%	94.2%	+0.2%
Plumbing	86.4%	73.7%	-12.7%
Concrete	84.8%	76.9%	-7.9%
Machinery & Equipment	81.8%	80.8%	-1.0%

Note: *n = 69; ** n = 52, ***Δ% represents the percent change from 2005 to 2021

Table 2 shows the means and incremental changes for each of those competency groups. Respondents identified the level of importance for each of the nine competency groupings, which was on a one to five Likert-type scale, with 1 (not important) – 5 (very important). Hand/Power Tools had the highest mean value in this study, which is identical to the Burris et al. (2005) study. Following behind Hand/Power Tools in second and third place is Ag Power and Electricity. For this study, Machinery and Equipment had the lowest mean value, as opposed to the original study which had Plumbing as the lowest mean value (Burris et al., 2005).

Table 2

Mean Level of Perceived Importance for Competency Groupings

Competency Grouping	*2005 M*	*2021 M*	Δ%*
Hand/Power Tools	4.21	4.37	+.16
Ag Power	4.11	4.29	+.18
Electricity	3.98	4.24	+.26
Project Planning and Materials Selection	3.76	3.90	+.14
Metal Fabrication	3.72	3.91	+.19
Building/Construction	3.89	4.05	+.16
Concrete	3.70	3.86	+.16
Machinery and Equipment	3.56	3.76	+.20
Plumbing	3.53	3.97	+.34

Note: *Δ% represents the percent change from 2005 to 2021

Table 3 shows the means and incremental changes for the perceived level of preparation for competency groups. Respondents identified the level of preparation for each of the nine competency groupings, which was on a one to five Likert-type scale, with one being "Not Prepared" and five being "Very Prepared". The highest mean was reported for Hand/Power Tools (M = 3.69) indicating "Somewhat Prepared". Four of the other eight competency groups had a rating of "Somewhat Prepared" with means ranging from 3.13-3.56. Those competencies were Ag Power, Electricity, Building/Construction, and Metal Fabrication. The remaining four competencies were rated as "Poorly Prepared" with mean values ranging from 2.35-2.90. These competencies were Plumbing, Concrete, Project Planning and Materials Selection, and Machinery and Equipment. The significant changes from the original study to this study can be noted as Plumbing having +.33% change and Electricity having a +.20% change (Burris et al., 2005).

Table 3

Perceived Level of Preparation for Competency Groupings

Competency Grouping	*2005 M*	*2021 M*	Δ%*
Hand/Power Tools	3.51	3.69	+.18
Ag Power	3.42	3.56	+.14
Electricity	3.13	3.33	+.20

Project Planning and Materials Selection	2.90	2.88	-.02
Metal Fabrication	3.17	3.13	-.04
Building/Construction	3.01	3.17	+.16
Concrete	2.85	2.91	+.06
Machinery and Equipment	2.35	2.49	+.14
Plumbing	2.65	2.98	+.33

Note: 1=Not Prepared, 2=Poorly Prepared, 3=Somewhat Prepared, 4=Prepared, 5=Very Prepared.
*Δ% represents the percent change from 2005 to 2021

Figure 2 represents participants responses if their state requires agricultural mechanics for teacher certification. Out of the 35 states represented in this study, 25 reported that they do require agricultural mechanics for certification. However, ten states had no requirement for agricultural mechanics.

Figure 2.

Number of State Requiring Credits in Agricultural Mechanics (*n* = 35)

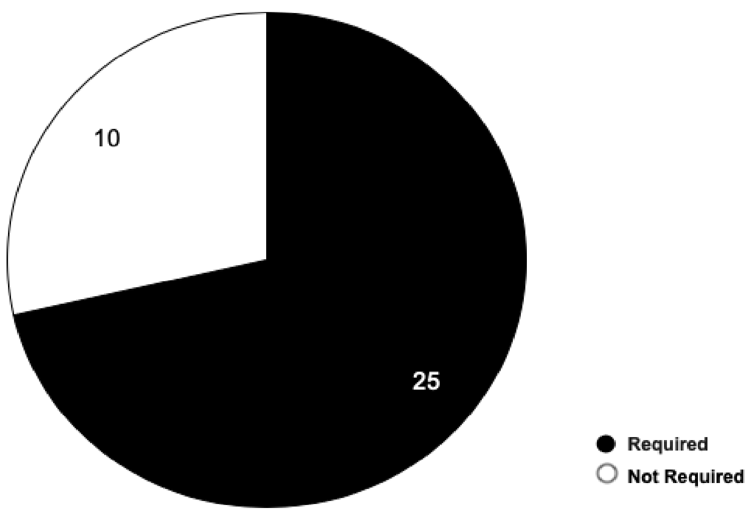


Table 4 shows the number of agricultural mechanics credits required for candidates to complete for their program. Over 97 percent of participants stated that for program completion that they required some agricultural mechanics courses. Only one institution (3.3%) indicated that no credits in agricultural mechanics were required for their program. The majority of programs required 5 to 8 credits required as indicated by over 43 percent of the respondents. The modal category of this study was congruent with the Burris et al. (2005) study. One notable difference between this study and the original study was that no institutions required 17 to 20 credits of agricultural mechanics credits, unlike Burris et al.'s (2005) study which had three institutions requiring 17 to 20 credits.

Table 4

Number of Agricultural Mechanics Credits Required for Program Completion (n = 30)

Competency Grouping	2005 *f*	2021 *f*	Δ*f*
0	2	1	-1
1 to 4	5	7	+2
5 to 8	26	14	-12
9 to 12	23	9	-14
13 to 16	10	1	-9
17 to 20	3	0	-3

Note: *Δ represents the frequency change from 2005 to 2021

Table 5 summarizes the prevalence with which agricultural mechanics specific courses were required. Thirty-one of the respondents stated that a General Agricultural Mechanics course was a completion requirement. In 2005, forty-two indicated that courses in General Ag Mechanics were required for completion, however in 2021, that total dropped to only seventeen. Thirty-six participants indicated that courses in Engines and/or Power and Machinery were required in their department in 2005. Now, that total only reaches seventeen. In 2021, the other competency groupings such as Metal Fabrication, Methods, Ag Structures, Electricity and Other have consistently lessened when compared to the original study completed by Burris et al. (2005).

Table 5

Types of Agricultural Mechanics Courses Required for Program Completion (n = 31)*

Competency Grouping	2005 *f*	2021 *f*	Δ*f***
General Ag Mechanics	42	17	-25
Engines/Power and Machinery	36	18	-18
Metal Fabrication	31	17	-14
Methods	26	11	-15
Ag Structures	22	12	-10
Other[a]	14	8	-6
Electricity	7	2	-5

Note. *Only 31 respondents provided a list of required courses. Some institutions required courses in more than one content area. Other[a] includes surveying, safety, global positioning, and computer applications. **Δ represents the frequency change from 2005 to 2021.

Table 6 demonstrates the range of departments that teach the agricultural mechanics courses. A majority (55.8%) of programs stated that at least one of the courses required for program completion was taught by their home department of the teacher preparation program. Nearly 33% (17) of respondents reported that other departments within their college taught the agricultural mechanics related course. Only nine (7.6%) programs reported that a non-agriculture related department taught the required course and less than three percent (2) reported that agricultural mechanics credits only be available at another institution.

Table 6

Department Offering Required Courses in Agricultural Mechanics (n = 44)

Course Location	2005 *f*	%	2021 *f*	%	Δ*f***
Home Department	40	57.97	29	55.8	-11
Other Agricultural Department	27	39.13	17	32.7	-10
Department other than Agriculture	4	4.35	9	7.6	+5
Outside of the institution	2	1.45	2	2.8	0

Conclusions, Discussion, and Recommendations

It can be concluded that the same content areas within agricultural mechanics were found to still be important today as in 2005. Agricultural mechanics is still seen as an important component if not more important today in post-secondary agricultural education teacher preparation programs, which corroborates the findings from Burris et al. (2005). This study also found that post-secondary agricultural education teacher preparation programs still require, on average, the same amount of credit hours as reported by Burris et al. (2005).

In 2005, Burris et al., found that 11 states did not require agricultural mechanics courses, which is similar to the 10 states in our study that also do not require these courses. This is concerning because all states identified that agricultural mechanics is important at the post-secondary level, yet ten do not require it. Even in the states that do require agricultural mechanics they only feel that their students are somewhat prepared to teach these concepts. This begs the question, why are we not preparing pre-service teachers better in the area of agricultural mechanics? Is it due to the price of materials to teach or the number of required courses needed for licensure doesn't leave room for these skills-based courses?

According to CMATE, teachers need to have knowledge and skills about agricultural technology to facilitate and prepare practical experiential hands-on learning opportunities in their classrooms (Rosencrans & Martin, 1997). With the results of this study, agricultural mechanics instruction at the post-secondary level is still not adequately preparing students to be successful at teaching agricultural concepts. This has led to the abundance of current teachers and pre-service teachers not feeling confident in teaching many of the concepts within agricultural mechanics (Blackburn et al., 2015; Saucier & McKim, 2011' Shultz et al., 2014; Whitehair et al., 2020: Wells et al., 2021). This leads to multiple questions including: Are Is there enough space in the teacher certification degree plans to add more coursework? Are there enough professors at the post-secondary level proficient enough to teach agricultural mechanics? And, is the quality of instruction currently being offered provide a solid foundation to build on?

There has been a push in recent years of offering professional development in agricultural mechanics, but this only helps once pre-service teachers have a job. What can be done within our agricultural education teacher preparation programs? Do we outsource agricultural mechanics to a community college with the resources, ask other departments to teach these courses, or continue to let it go by the wayside? We believe that looking at state curriculums to identify the agricultural mechanics competencies that are required of secondary programs to teach and start creating an avenue for students to get these experiences and gain foundational knowledge in agricultural mechanics. We also need to look at creating possible graduate level opportunities for students to gain these skills during the first few years of their teaching career.

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