

# The State of Agricultural Mechanics in the Preparation of School-Based Agricultural Education Teachers

## Abstract

*Agricultural mechanics is a primary subject area in school-based agricultural education (SBAE). Despite a high prevalence in SBAE, preservice and in-service SBAE teachers have frequently expressed concerns regarding teaching agricultural mechanics. Early 21<sup>st</sup>-century research documented the characteristics of preservice SBAE teacher training in agricultural mechanics, although more recent studies have suggested that the agricultural mechanics training requirements have changed. This study sought to compare the agricultural mechanics preparation of preservice SBAE teachers between 2000 and 2021. A survey instrument was distributed to a representative of every institution with an undergraduate SBAE teacher preparation program in the contiguous United States, resulting in an 86.7% response rate. We drew comparisons in the data to previous studies from 2000 and 2005. The findings included a reduced average number of required agricultural mechanics credit hours over time. Faculty perceptions of importance and preservice teacher preparation had increased slightly; however, deficits were in all competency groups. Further research is warranted to determine the perceptions of preservice and in-service SBAE teachers regarding agricultural mechanics. Recommendations include that teacher educators evaluate current preparation methods for preservice SBAE teachers and provide professional development in the areas of the greatest observed training deficits.*

**Keywords:** agricultural mechanics, school-based agricultural education, teacher preparation

## Introduction

In modern school-based agricultural education (SBAE) programs, laboratory instruction has emerged as a principal fixture of formal instruction and often provides students with experiential learning opportunities that help them acquire agricultural-based knowledge and skills (Croom, 2008). As a result, SBAE teachers must have a wide variety of technical skills across agricultural education's diverse curriculum to be considered effective (Albritton & Roberts, 2020; Jenkins et al., 2010; Roberts et al., 2007; Roberts & Dyer, 2004).

For example, agricultural mechanics has been considered a fundamental content area of agricultural education, and researchers have identified dedicated agricultural mechanics facilities among the most common forms of SBAE laboratories (Phipps, 2008; Shoulders & Myers, 2012; Talbert et al., 2022; Twenter & Edwards, 2017). However, agricultural mechanics as a subject area varies greatly in content and, as a result, demands a high degree of technical skill to be taught effectively (Albritton & Roberts, 2020; Ford et al., 2008). Consequently, of the technical skills deemed necessary for beginning SBAE teachers, Albritton and Roberts (2020) found that 34% were directly related to agricultural mechanics. Despite this importance, first-year SBAE teachers have ranked agricultural mechanics lower than any other content area in perceived teaching self-efficacy (Burris et al., 2010). SBAE researchers have often found training deficits in agricultural mechanics among SBAE teachers, and frequent calls for expanded professional development on the subject are present throughout the literature (Burris et al., 2010; Figland et al., 2019; McKim & Saucier, 2011; Peake et al., 2007; Saucier & McKim, 2011; Saucier et al., 2014; Shultz et al., 2014). Similarly, concerns about teaching agricultural mechanics are present even before SBAE teachers enter the field; for example, empirical evidence has found that agricultural education undergraduates often lack the confidence and skills needed to successfully teach the subject at the secondary level (Blackburn et al., 2015; Granberry et al., 2022; McKim & Saucier, 2013; Saucier & McKim, 2011; Tummons et al., 2017). As such, adequate preparation at the post-secondary level has become more

paramount, especially considering Smith et al. (2022) report that illuminated that newly licensed, recent undergraduates accounted for 35.3% of new SBAE teacher hires nationally.

On this point, Hubert and Leising (2000) reported a national average of 6.7 required college credit hours for preservice SBAE teachers. Five years later, Burris et al. (2005) reported the most recent detailed data on preservice teachers' agricultural mechanics training, finding that 89% of teacher education programs required five or more credits in the area for graduation, with an average requirement of 9.1 credit hours. However, more recent research has indicated a decline in the number of post-secondary course credits required in agricultural mechanics taken by SBAE instructors (Byrd et al., 2015; Easterly et al., 2018; McKim & Saucier, 2013). This perceived reduction in post-secondary agricultural mechanics requirements is especially troubling, given the positive impact of enrolling in such courses on the outcomes of preservice teachers, especially concerning the understanding of key concepts and perceived self-efficacy to teach the content (Blackburn et al., 2015; Leiby et al., 2013, Whitehair et al., 2020). Additionally, instructors of post-secondary agricultural mechanics courses have been identified as impactful mentors for preservice and early career teachers in teaching the content (Ford et al., 2008; Granberry et al., 2022; Horstmeier & Morgan, 2007). The influence of post-secondary agricultural mechanics instruction on secondary teaching outcomes, coupled with the perception of reduced training in the content area, necessitates an updated study on the level and content of agricultural mechanics coursework available for preservice SBAE teachers.

### Theoretical and Conceptual Frameworks

Because laboratory instruction is inherently experiential, the role of experiential learning in coursework involving a high instance of laboratory instruction, such as agricultural mechanics, is paramount. For this reason, John Dewey's ideological lens of experiential learning from his 1938 work *Experience and Education* serves as the overarching theoretical framework for this study. Dewey (1938) saw the role of experience in education as a process by which individuals learn from their overall experiences, reflect, and apply what they have learned to new situations. In Dewey's view, the role of contextualized learning was to provide continuity of experience to the learner, motivating them to continue seeking knowledge and skills. He posited, "Continuity and interaction in their active union with each other provide the measure of the educative significance and value of an experience" (1938, p. 44-45). In the case of agricultural mechanics education for preservice teachers, post-secondary coursework often provides the foundational experiences necessary to develop the skill sets required for teaching the content to their future students. As the context shifts from the role of a student in a post-secondary course to that of an instructor at the secondary level, the experiential learning derived from prior agriculture mechanics coursework can guide the delivery of agricultural mechanics learning outcomes and bolster interest in further professional development on the topic (Leiby et al., 2013).

Experiential learning also plays a foundational role in Roberts and Ball's (2009) model for agricultural subject matter as content and a context for teaching, which conceptually underpinned the study. The dual goal of the model is to produce life-long learners who are agriculturally literate citizens and a skilled agricultural workforce. However, the model does not conceptualize these outcomes as mutually exclusive. Instead, Roberts and Ball (2009) discussed the complex need for an area of overlap in both parts, "[a]gricultural educators do not have the luxury of defining how students apply what is learned; that is on the student. Further complicating things, high school students likely do not know how they might apply something in the future" (p. 88). In agricultural mechanics education, secondary students' learning outcomes relate to their teachers' knowledge of the content and related technical skills as a base for the integrated curriculum needed to facilitate learning. At its inception, the design of SBAE instruction in agricultural mechanics sought to train students in the operation, maintenance, and repair of farm equipment they were likely to encounter in their work as farmers and ranchers (True, 1929). However, as agricultural production systems diversified, agricultural mechanics education adapted to include skillsets beyond

production machinery, primarily due to anticipation that SBAE students would need a technical aptitude for both on and off-farm applications (Twenter & Edwards, 2017). More recently, the career outcomes for students in agricultural mechanics-based career pathways addressed the many facets of modern agricultural industries (Hancock et al., 2017). In presenting their model, Roberts and Ball (2009) recognized that SBAE agricultural mechanics coursework has proven to be a valuable context for learning applicable across academic and agricultural disciplines. Due to the role of the SBAE teacher in this process, this study's primary focus was the foundational learning experiences of SBAE teachers in agricultural mechanics in post-secondary teacher preparation programs.

### **Purpose and Objectives**

The purpose of this study was to describe the level of agricultural mechanics preparation offered for preservice SBAE teachers between 2000 and 2021. Because this study aimed to assess the technical skill development available to preservice teachers, who will potentially use those skills to prepare students for skilled agricultural work, it aligned with the American Association for Agricultural Education (AAAE) research values associated with advancing public knowledge of AFNR systems (AAAE, 2023). We developed the following research objectives to guide the study:

1. Describe post-secondary institutions offering a four-year undergraduate degree designed to prepare students for careers as SBAE teachers.
2. Describe selected characteristics related to post-secondary instruction in agricultural mechanics in comparison to similar characteristics reported by Hubert and Leising (2000) and Burris et al. (2005).
3. Describe teacher educators' perceptions of the importance of selected agricultural mechanics content areas for agricultural education graduates in comparison to levels reported by Burris et al. (2005).
4. Describe teacher educators' perceptions of preparation for agricultural education graduates in selected agricultural mechanics content areas in comparison to levels reported by Burris et al. (2005).

### **Methods**

This descriptive study sought to expand on the research of Hubert and Leising (2000) and Burris et al. (2005) by providing an updated view of the preparation of preservice teachers in agricultural mechanics by evaluating (a) requirements for degree completion, (b) the content of post-secondary agricultural mechanics courses available to preservice teachers, and (c) perceptions of specific agricultural mechanics topics in teacher preparation programs.

### **Target Population**

All post-secondary institutions offering four-year undergraduate degree programs designed to train SBAE teachers in the United States served as the target population for this study. We used a list of AAAE member institutions as the base of the target population frame (Kleinjan & Marx, 2018). After reviewing the list for frame error, a panel of teacher educators determined that six institutions on the list did not meet the qualifications for inclusion in this study. Additionally, we determined that 11 institutions absent from the AAAE list met the inclusion criteria and added them to the population frame. After review, the target population was determined to be 103 institutions. Dillman et al. (2014) state that a census is appropriate "when the population is so small that the additional costs of surveying everyone are fairly negligible" (p. 82). Based on the relatively small size of the target population and the lack of additional costs associated with sending the Qualtrics invitation to the entire population, we determined that a census was the most appropriate sampling method for the study. Using online faculty directories, we identified a representative for each institution and had the representative contact list confirmed by a panel of current SBAE teacher educators at Louisiana State University. We attempted to identify a representative who was a faculty

member in the SBAE teacher preparation program and listed as the instructor of at least one course involving agricultural mechanics topics or laboratory management. If we did not identify a representative meeting both of these qualities, an SBAE teacher educator at the institution was selected. When we did not identify any agricultural education faculty for an institution, the chair of the department housing the SBAE teacher preparation program was selected to represent the institution.

### **Instrumentation**

The instrument utilized for data collection in this study was a modified version of the instrument developed by Burris et al. (2005). After obtaining an original copy of the instrument, a review was conducted with a panel of three experts to determine necessary alterations to the instrument to align it with this study's objectives. Suggested modifications included adding items designed to collect descriptive data related to the institution, the SBAE teacher preparation program, and items designed to collect data comparable with the findings of Hubert and Leising (2000). The modified instrument retained all items in the original nine agricultural mechanics content areas included by Burris et al. (2005): *metal fabrication, hand and power tools, project planning and materials selection, electricity, concrete, plumbing, building construction, ag power, and machinery and equipment*; however, we renamed *ag power* to *outdoor power equipment and small gasoline engines* to reflect modern content more accurately. Additionally, we changed the wording of some competencies for clarity and added new competencies where necessary to reflect changes in modern agricultural mechanics technology. New competencies were derived from the Power, Structural, and Technical System (PSTS) Pathway in the Agriculture, Food, and Natural Resources (AFNR) Standards from The National Council for Agricultural Education (2015) and state standards relating to agricultural mechanics education. We also added a tenth content area, *renewable energy*, due to the inclusion of the topic in the PSTS Pathway in the National AFNR Standards and modern references for secondary agricultural mechanics (Hancock et al., 2017; Koel et al., 2013; National Council for Agricultural Education, 2015). After we finalized all instrument updates, the ten content areas were represented by 59 competencies, each containing between four and eight competencies.

One section of the instrument asked participants to rate their perception of the 59 competencies' importance on a five-point Likert-type scale, with one indicating the lowest level of importance and five indicating the highest. A subsequent section also asked participants to indicate their perception of the level of preparation that preservice SBAE teachers in their programs received on those same competencies using a similar five-point, Likert-type scale.

A panel of experts consisting of SBAE teacher educators with experience teaching agricultural mechanics content and faculty with expertise in instrument development reviewed the instrument for content and face validity. We used IBM SPSS v.27 for post-hoc reliability analysis and descriptive statistics. Cronbach's (1951) alpha values for items measuring perceived levels of importance ranged from .83 to .95. Items measuring perceived levels of preparation yielded values ranging from .83 to .96. The reliability values for all scales were above an acceptable threshold of .70 and similar to those reported by Burris et al. (2005) (Field, 2018).

### **Data Collection and Analysis**

We collected data via Qualtrics during the Fall 2021 semester, using Dillman et al. (2014) tailored design method in an attempt to maximize the response rate. An initial email containing a link to the survey was sent to all contacts identified for the target population, followed by three subsequent reminder emails sent at eight-day intervals. A week after the final reminder email, we attempted to contact non-respondents by email and phone to clarify the correct contact information and ask for participation. If we could not reach the person initially designated as the representative for a particular institution, we attempted to contact an alternative representative who met the previously outlined qualifications.

When data collection concluded, 94 individuals responded to our invitation to participate, constituting 91.3% of the target population. Of the respondents, five representatives indicated that their institutions did not have an undergraduate agricultural education program designed to train SBAE teachers, indicating a small degree of frame error. Consequently, the target population was adjusted from 103 to 98 institutions ( $N = 98$ ) to accommodate this error. Additionally, four respondents indicated they did not wish to participate, and we could not identify a new representative for their institutions. After the frame error adjustment, 85 respondents provided data usable for analysis, constituting a usable response rate of 86.7%. Lindner et al. (2001) concluded that procedures for controlling nonresponse error are unnecessary when survey response rates are over 85%; therefore, we deemed the response rate acceptable for the study.

We employed descriptive statistics to report findings from the data collected for the study. In an attempt to replicate Burris et al. (2005) data analysis methods, we calculated two mean values for each of the 59 agricultural mechanics competencies: one for *perceived importance* and one for *perceived level of preparation*. For each of the ten content areas, we generated *perceived importance* and *perceived level of preparation* composite means from the mean values produced from the competencies in that area. These composite means were then compared to the findings of Burris et al. (2005). We note that using mean values for ordinal data, like the Likert-type scales used for each competency, is not a preferred analysis method; their use in this study was necessary to generate results comparable to the findings of Burris et al. (2005).

## Findings

### **Objective One: Describe post-secondary institutions offering a four-year undergraduate degree designed to prepare students for careers as SBAE teachers.**

Most ( $n = 78$ ; 91.8%) of the institutions in this study were public colleges or universities, with the largest subgroup of public institutions ( $n = 41$ ; 48.3%) being 1862 or 1890 Land-grant Universities. Conversely, private colleges and universities comprised the smallest group of responding institutions ( $n = 7$ ; 8.2%). The majority ( $n = 52$ ; 61.2%) of institutions had undergraduate student populations greater than 10,000, and almost all operated on semester-based academic calendars ( $n = 82$ ; 96.5%). Although not part of the survey instrument, 12 institutions designated as *Hispanic-serving* by the U.S. Department of Education (2020) provided data usable for analysis. Slightly more than half ( $n = 43$ ; 50.6%) of the responding institutions were in the Southern Region of the AAEE, with the North Central Region constituting slightly less than one-third ( $n = 27$ ; 31.8%) and the Western Region representing the smallest group of respondents ( $n = 15$ ; 17.6%). Respondents reported a total of 964 SBAE teacher preparation program graduates for the 2020-2021 academic year, of whom 853 (88.5%) earned teacher certifications. Although the average numbers of students graduating and certifying as teachers were 11.5 and 10.7, respectively, over one-third of the institutions in this study produced five or fewer SBAE graduates ( $n = 30$ ; 35.7%) during the 2020-2021 academic year. The average number of newly certified SBAE teachers reported in this study represents a 12.63% increase from the average of 9.5 reported by Hubert and Leising (2000).

### **Objective Two: Describe selected characteristics related to post-secondary instruction in agricultural mechanics in comparison to similar characteristics reported by Hubert and Leising (2000) and Burris et al. (2005).**

Most ( $n = 77$ ; 91.6%) of the institutions in the study offered courses in agricultural mechanics, agricultural technology and equipment, agricultural power, structural and technical systems, or similarly aligned subjects. Over 70% ( $n = 54$ ; 70.1%) of the institutions with agricultural mechanics coursework offered those courses in the same academic department as the SBAE teacher preparation program. The most preferred minimum qualifications for an instructor of agricultural mechanics courses for preservice SBAE teachers was a doctoral degree in agricultural education ( $n = 37$ ; 44.0%) or a master's degree in agricultural education ( $n = 21$ ; 25.0%). Of the institutions offering agricultural mechanics courses ( $n = 77$ ), 97.4% required preservice SBAE teachers to complete at least one course, with 5.8 credit hours as the average

requirement across all institutions. This average ( $M = 5.8$ ) was 13.43% less than the findings of Hubert and Leising (2000) ( $M = 6.7$ ) but was reduced by 36.26% from the findings of Burris et al. (2005) ( $M = 9.1$ ). General Agricultural Mechanics ( $n = 68$ ; 88.3%) and Welding/Metal Fabrication ( $n = 56$ ; 72.7%) were the most common content areas included in required courses. All agricultural mechanics content areas were more frequently part of the required coursework than the findings of Hubert and Leising (2000); however, only *General Agricultural Mechanics* (2005 – 60.87%; 2021 – 79.22%), *Metal Fabrication* (2005 – 44.93%; 2021 – 54.55%), *Agricultural Mechanics Teaching Methods* (2005 – 37.68%; 2021 – 62.34%), and *Electricity* (2005 – 10.14%; 2021 – 27.27%) displayed increases as the primary course content from the findings of Burris et al. (2005). Most ( $n = 55$ ; 64.7%) respondents offered agricultural mechanics teaching methods courses, which were required coursework at more than half of the institutions ( $n = 48$ ; 56.5%). The average number of required agricultural mechanics teaching methods credit hours was 3.6, an increase from the findings of Hubert and Leising (2000) ( $M = 1.3$ ).

The percentage of respondents with a preference for post-secondary agricultural mechanics instructors with a graduate degree in agricultural education (69.0%) rose from the findings of Hubert and Leising (2000) (34.8%). Similarly, agricultural mechanics courses were more commonly offered in the same department as the SBAE teacher preparation program (70.1%) than the findings of Burris et al. (2005), who reported 57.7%.

### Objective Three: Describe teacher educators' perceptions of the importance of selected agricultural mechanics content areas for agricultural education graduates in comparison to levels reported by Burris et al. (2005).

The eight metal fabrication competencies ranged in average perceived importance from 3.4 to 4.6. The overall composite mean for all associated competencies ( $M = 3.8$ ;  $SD = 0.69$ ) indicated that metal fabrication was perceived as *important* (see Table 1). The metal fabrication composite mean in this study represents a 2.70% increase in average perceived importance over time.

**Table 1**

#### *Comparison of Perceived Importance for Competency Groups*

Competency Grouping	Burris et al. (2005) ( $n = 69$ ) Importance		Current Study ( $n = 80$ ) Importance		$\Delta\%$
	$M$	$SD$	$M$	$SD$	%
Metal Fabrication	3.7	0.70	3.8	0.69	2.70
Hand and Portable Power Tools	4.2	0.62	4.3	0.64	2.38
Project Planning and Materials Selection	3.8	0.63	3.8	0.76	0.00
Electricity	4.0	0.70	4.0	0.69	0.00
Concrete	3.7	0.85	3.8	0.91	2.70
Plumbing	3.5	0.93	3.8	0.88	8.57
Building Construction	3.9	0.69	3.9	0.68	0.00
Outdoor Power Equipment and Small Engines	4.1	0.70	4.1	0.68	0.00
Machinery and Equipment	3.6	0.75	3.7	0.79	2.78
Renewable Energy <sup>2</sup>	-	-	3.1	1.05	-

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*Note*<sup>1</sup>. Importance Scale: 1 = *Not Important*, 2 = *Of Little Importance*, 3 = *Somewhat Important*, 4 = *Important*, 5 = *Very Important*

*Note*<sup>2</sup>. Renewable Energy was not present in the original instrument used by Burris et al. (2005).

The hand and portable power tool group included four competencies that ranged in average perceived importance from 3.3 to 4.7, with a composite mean ( $M = 4.3$ ;  $SD = 0.64$ ) indicating that the competency group overall was perceived as *Important*. Overall, faculty members perceived hand and portable power tool competencies as the most important of all competency groups in the study. Additionally, the hand and portable power tool content area displayed an increase of 2.38% in average importance from the findings of Burris et al. (2005).

Project Planning and Materials Selection included seven competencies, ranging from 3.3 to 4.2 in mean perceived importance. The resulting composite mean of ( $M = 3.8$ ;  $SD = 0.76$ ) indicated a perception of *important*; however, this value did not exhibit any change from the findings of Burris et al. (2005). A similar lack of difference between the studies was noted in the electricity content area, which had a composite mean of 4.0 ( $SD = 0.69$ ), indicating it was perceived as *important*. The composite mean was calculated from seven competencies, which ranged in mean perceived importance from 3.2 to 4.6. Concrete, which consisted of four competencies with mean ratings indicating respondents perceived them as *important*. The individual competency means ranged from 3.6 and 4.1 for a composite mean of 3.7 ( $SD = 0.85$ ), a 2.70% increase from the findings of Burris et al. (2005).

The plumbing content area exhibited the greatest difference in perceived importance from Burris et al. (2005) at 8.57%. Plumbing had a composite mean of 3.8 ( $SD = 0.69$ ), comprised of four competencies ranging from 3.4 to 4.3 in average perceived importance. Building Construction carried a similar composite mean ( $M = 3.9$ ;  $SD = 0.68$ ) calculated from seven competencies; however, no difference in perceived importance from this study and Burris et al. (2005) was present. A lack of difference in perceived importance was also noted for outdoor power equipment and small engines ( $M = 4.1$ ;  $SD = 0.68$ ), which included six competencies. Faculty perceptions of importance in this area ranged from 3.9 to 4.6, with an overall perception of *important*. Perceptions associated with agricultural machinery and equipment were analyzed based on seven competencies ranging in average perceptions of importance from 3.3 to 4.3, with a composite mean of 3.7 ( $SD = 0.79$ ). This composite mean was 2.78% higher than the findings of Burris et al. (2005).

The final content area was renewable energy, a new addition to Burris et al. (2005) original instrument, which comprised five competencies. Faculty members' perceived importance for these competencies averaged between 2.8 and 3.6, with a composite mean for the content area ( $M = 3.1$ ;  $SD = 1.05$ ) revealing they perceived the content area as *somewhat important*. Because renewable energy competencies were not present in the Burris et al. (2005) instrument, no data were available for comparison.

Respondents perceived all competencies as *important*, except for *renewable energy* ( $M = 3.1$ ;  $SD = 1.05$ ), which was perceived as *somewhat important*. Of the nine competency groups shared between this study and Burris et al. (2005), five displayed differences in importance; metal fabrication, hand and portable power tools, concrete, plumbing, and machinery and equipment. Although these differences represented increases in perceived importance, they only ranged from 2.38% to 8.57% between the two studies.

**Objective Four: Describe teacher educators' perceptions of preparation for agricultural education graduates in selected agricultural mechanics content areas in comparison to levels reported by Burris et al. (2005).**

Faculty perceptions of preservice SBAE teachers' level of preparation in the metal fabrication competencies ranged in average value from 2.2 to 4.1. The overall composite mean for faculty members' perceptions of preservice teachers' preparation in metal fabrication was 3.3 ( $SD = 0.85$ ), revealing that

faculty perceived undergraduates to be *somewhat prepared* in metal fabrication (see Table 2). This value represented a 3.31% increase in average perceived preparation from the findings of Burris et al. (2005).

**Table 2**

*Comparison of Perceived Preparation for Competency Groups*

Competency Grouping	Burris et al. (2005) ( <i>n</i> = 69) Preparation		Current Study ( <i>n</i> = 80) Preparation		$\Delta\%$ %
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Metal Fabrication	3.2	0.98	3.3	0.85	3.13
Hand and Portable Power Tools	3.5	0.95	3.8	0.72	8.57
Project Planning and Materials Selection	2.9	0.91	3.1	0.84	6.90
Electricity	3.1	1.08	3.3	0.92	6.45
Concrete	2.9	1.20	2.8	1.15	-3.45
Plumbing	2.7	1.13	3.0	1.09	11.11
Building Construction	3.0	1.04	3.2	0.90	6.67
Outdoor Power Equipment and Small Engines	3.4	1.19	3.6	1.00	5.88
Machinery and Equipment	2.4	1.04	2.6	0.95	8.33
Renewable Energy <sup>2</sup>	-	-	2.0	0.96	-

*Note*<sup>1</sup>. Preparation Scale: 1 = *Not Prepared*, 2 = *Poorly Prepared*, 3 = *Somewhat Prepared*, 4 = *Prepared*, 5 = *Very Prepared*

*Note*<sup>2</sup>. Renewable Energy was not present in the original instrument used by Burris et al. (2005).

Mean perceptions of preservice teachers' level of preparation in hand and portable power tools ranged in average value from 2.2 to 4.4, with a composite mean of 3.8 (*SD* = 0.72). This content area exhibited the second-highest difference in perceived preparation over time (8.57%). Faculty perceptions of preservice teachers' preparation in the project planning and materials selection competencies ranged in average value from 2.3 to 3.6, with a composite mean of 3.1 (*SD* = 0.84), a 6.90% increase from 2005. A similar increase of 6.45% was present in perceptions of preparation in electricity. These competencies ranged in average value from 2.3 to 4.0, with a composite mean of 3.3 (*SD* = 0.92).

The composite mean of faculty perceptions of preparation in the concrete competencies averaged from 2.6 to 3.2, with a composite mean of 2.8 (*SD* = 1.15). When compared to the composite mean reported by Burris et al. (2005), concrete was the only competency group in this study that exhibited a decrease in perceived preparation (-3.45%). Conversely, the composite mean of faculty perceptions of preservice teachers' preparation in the plumbing competencies (*M* = 3.0; *SD* = 1.09) exhibited the greatest percentage increase (11.11%) from 2005 of all competency groups in the study.

Perceptions of preparation in the building construction competencies ranged in average value from 2.7 to 3.9, with a composite mean preparation value of 3.2 (*SD* = 0.90), an increase of 6.67% from the findings of Burris et al. (2005).

Perceptions of preservice teacher preparation in outdoor power equipment and small engines competencies averaged from 3.1 to 4.1. These values contributed to a perceived preparation composite

mean of 3.6 ( $SD = 1.00$ ), making this content area one of only two that faculty perceived preservice teachers as *prepared*. Additionally, the composite mean of 3.6 represents a 5.88% increase from 2005. Perceptions of preservice teacher preparation in agricultural machinery and equipment competencies ranged from 2.2 to 3.3, contributing to a composite mean of 2.6 ( $SD = 0.95$ ), an 8.33% increase from the previous study.

Faculty perceptions of preservice teachers' level of preparation in the renewable energy competencies ranged from 1.7 to 2.5, contributing to a composite mean ( $M = 2.0$ ;  $SD = 0.69$ ) that indicated faculty viewed their students as *poorly prepared* in renewable energy content. As with the perceptions of importance, the lack of inclusion of renewable energy competencies in the Burris et al. (2005) instrument resulted in no comparable data. Faculty members perceived preservice SBAE teachers as most prepared in *hand and portable power tools* ( $M = 3.8$ ;  $SD = 0.72$ ) and least prepared in competencies related to *renewable energy* ( $M = 2.0$ ;  $SD = 0.96$ ). Average perceptions of *prepared* were present for hand and portable power tools and outdoor power equipment and small engines. The composite means for all other content areas indicated that faculty perceived students as *somewhat* or *poorly prepared*.

### Conclusions, Discussion, and Implications

This investigation revealed the diversity of preservice SBAE teacher preparation across the nation and presented that agricultural mechanics education in post-secondary settings has become far from uniform. First, the finding that 91.6% of the institutions offered agricultural mechanics coursework for preservice SBAE teachers is both promising and worrisome. This figure suggests that most preservice SBAE teachers in the United States have some access to agricultural mechanics training as part of their SBAE teacher preparation program. In light of the commonality of agricultural mechanics in secondary SBAE, training in the subject area is important (Albritton & Roberts, 2020; Phipps et al., 2008; Shoulders & Meyers, 2012). With the need for training in mind, the percentage of institutions offering agricultural mechanics coursework for preservice SBAE teachers (91.6%) is also troubling. Despite the high number of programs offering agricultural mechanics coursework, at least eight programs are preparing SBAE teachers without content-specific training in agricultural mechanics, which is the most common laboratory environment in SBAE and requires a high degree of technical competency (Albritton & Roberts, 2020; Twenter & Edwards, 2017).

Beyond the number of institutions without post-secondary agricultural mechanics coursework lies the fact that SBAE teacher training in agricultural mechanics is a well-documented need for both preservice (Burris et al., 2010; Blackburn et al., 2015; Granberry et al., 2022; Hainline et al., 2018; Saucier & McKim, 2011; Tummons et al., 2017) and in-service teachers (Figland et al., 2019; McKim & Saucier, 2011; McKim & Saucier, 2013; Peake et al., 2007; Saucier et al., 2014; Swafford & Hagler, 2018; Toft et al., 2021; Wells et al., 2021). The accessibility to agricultural mechanics coursework and well-documented training needs in the subject area bolster the conclusion that the amount or the quality of post-secondary agricultural mechanics training is not meeting the needs of the modern SBAE teaching environment.

The findings of this study documented that the average number of credit hours required for preservice SBAE teachers in agricultural mechanics content in 2021 decreased by 13.4% from the findings of Hubert and Leising (2000) but was reduced by 36.3% or 3.3 credit hours when compared to the findings of Burris et al. (2005). This finding was in alignment with Easterly et al. (2018), who reported an average requirement of 5.9 credit hours in power, structural, and technical systems for preservice teachers, and Byrd et al. (2015), Clark et al. (2021), and McKim and Saucier (2013), who observed reduced agricultural mechanics coursework reported by teachers in Iowa and Missouri, respectively. Based on the importance of post-secondary agricultural mechanics coursework to SBAE teachers' perceptions of their ability to teach the content, the overall decline in average required credit hours from 2000 to 2021 is likely a major contributing factor to the widely documented deficit in agricultural mechanics training experienced by SBAE teachers (Blackburn et al., 2015; Leiby et al., 2013; Whitehair et al., 2020).

Despite reduced credit hour requirements, this study's findings indicate that preservice teachers' exposure to *general agricultural mechanics*, *metal fabrication*, *agricultural mechanics teaching methods*, and *electricity* have all increased over the past two decades. When combined with a reduction in credit hours, this finding indicates that preservice SBAE teachers frequently encounter a greater breadth of content in a single course than in previous studies (Burris et al., 2005; Hubert & Leising, 2000). If a single course covers multiple agricultural mechanics content areas, we must question if preservice SBAE teachers encounter the content in sufficient depth to gain mastery.

Moreover, how do instructors decide which content to include in the limited credit hours and which to leave out? As a whole, the findings of this study indicate that faculty members perceive agricultural mechanics competencies as important and, compared to Burris et al. (2005), perceptions of importance have remained stable over time. However, Clark et al. (2021) found that over one-third of Iowa SBAE teachers had no post-secondary instruction in 38 of 54 agricultural mechanics skills, which aligns with this study's low perceptions of preparation. These findings imply that when instructional time is limited, faculty members familiar with the needs of teachers in their state may prioritize content based on local expectations.

In particular, the content area with the lowest level of perceived importance ( $M = 3.1$ ;  $SD = 1.05$ ) and lowest perceived preparation ( $M = 2.0$ ;  $SD = 0.96$ ) was renewable energy. The findings related to renewable energy are troubling, considering that the United States Energy Information Administration (2021) projects non-hydroelectric renewable energy sources to be the fastest-growing forms of energy generation in the U.S. and the domestic production and use of biofuels to increase through 2050. Additionally, the Bureau of Labor Statistics (2021) indicated that wind turbine service technicians and solar photovoltaic installers rank first and third, respectively, as occupations with the highest projected growth by 2029, with the boom in renewable energy showing instances of carry-over to agricultural industries (Hancock et al., 2017). Organizations like the AAAE value research related to increasing prosperity through innovation in AFNR systems, which bolsters the need for examining the low perceived importance of the innovative, rapidly growing renewable energy industry held by SBAE teacher educators (AAAE, 2023).

Overall, when comparing perceived importance to perceptions of preservice teacher preparation, all competency groups had an average perception of importance greater than the average perceived level of preservice teacher preparation, exhibiting only marginal changes from the findings of Burris et al. (2005). Based on these findings, many SBAE teacher educators were aware that they were operating in an extended agricultural mechanics training deficit. Why, then, have SBAE teacher preparation programs not altered their requirements to include more agricultural mechanics content if training needs are known? The answer is most likely the result of pressure on post-secondary leaders to reduce the number of credits for degree completion, with 120 credit hours now the standard for most four-year undergraduate degrees (Johnson et al., 2012). While students may have the opportunity to enroll in courses beyond those required for their degree plan, many states and institutions have adopted excess credit hour policies that place punitive surcharges on students who exceed the credit hour recommendations of their degree plans (Kramer et al., 2018). By design, these measures seek to reduce the time to degree completion and improve graduation rates; however, it appears that they have particularly affected SBAE teacher preparation through agricultural mechanics coursework reduction.

The combination of the highly technical nature of agricultural mechanics and the reduced credit hours for preservice teachers in the content area has created an evident issue. Preservice teachers have frequently expressed concerns regarding their self-efficacy in teaching agricultural mechanics (Burris et al., 2010; Granberry et al., 2022; Hainline et al., 2018; Tummons et al., 2017).

## Recommendations

### Recommendations for Research

This study's first objective aimed to describe institutions training preservice SBAE teachers, revealing differences in SBAE teacher training. Future research should explore these differences in how SBAE teachers are trained across various types of institutions in the United States. Of particular interest is understanding disparities in agricultural mechanics coursework and preservice teacher self-efficacy among students at Land Grant, public, and private institutions.

Given variations between previous studies and this research, it is recommended that periodic national studies be conducted to better understand the preparation of preservice teachers in agricultural mechanics. Additionally, the study's aspects related to importance and preparation should be replicated with preservice and in-service teachers at state, regional, and national levels to identify agricultural mechanics training needs from their perspectives. Similar studies have been published recently (Toft et al., 2021; Wells & Hainline, 2021) and should continue to monitor SBAE teachers' needs better. Such studies can help align professional development and teacher training with the actual needs of teachers in the field.

Despite concerns about preparation and the need for professional development, SBAE teachers continue to teach agricultural mechanics. Research is needed to determine where they acquire their agricultural mechanics knowledge and skills and to evaluate the effectiveness of these sources. Specifically, identifying highly effective forms of professional development for building agricultural mechanics skills would be valuable for teacher educators.

This study's findings also raise questions about renewable energy in SBAE. Despite industry trends and teaching standards recognizing the need for renewable energy training, SBAE teacher educators rated renewable energy competencies lowest in importance. Research is warranted to better understand SBAE teacher educators' and teachers' perceptions of renewable energy and their relation to SBAE instruction. Ruth et al.'s (2018) Decision-Making Model for ANR Science and Technology posits that acceptance or rejection of science and technology in agriculture and natural resources stems from a complex blend of theoretical frames to form motivation, opinion, and decision-making. This position could allow the Decision-Making Model to serve as a solid conceptual framework for studies related to perceptions of renewable energy in agricultural education (Ruth et al., 2018).

### **Recommendations for Practice**

Based on the findings of this study, institutions with SBAE teacher preparation programs should evaluate the coursework related to agricultural mechanics for preservice SBAE teachers. While approximately two courses in agricultural mechanics are common requirements, this varies across the country. SBAE teacher educators should determine the agricultural mechanics content knowledge necessary for their state's beginning SBAE teachers and assess if their coursework meets these needs.

The findings of this study display that, based on faculty perceptions, preservice and, consequently, early career teachers need training in multiple content areas under the agricultural mechanics umbrella, which aligns with recent needs assessments (Wells & Hainline, 2021). With current limitations to degree plans, SBAE teacher educators should determine if expanded coursework is possible and, if not, should seek to integrate agricultural mechanics content into existing agricultural education courses. Additionally, teacher educators should attempt to facilitate agricultural mechanics professional development for SBAE teachers, especially in content where they perceive training deficits.

Effective teacher preparation should adapt to ensure that preservice SBAE teachers can deliver meaningful learning experiences. This requires a strong foundation in agricultural mechanics and innovative professional development. SBAE teacher educators play a vital role in understanding their preservice teachers' strengths and weaknesses in the subject. Continuous improvement and innovation are essential to maintaining the prominence of agricultural mechanics in SBAE programs and ensuring the best possible learning outcomes for secondary students in agricultural mechanics courses.

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