AGROFORESTRY EDUCATION FOR HIGH SCHOOL AGRICULTURE SCIENCE:
A CASE STUDY of NOVEL CONTENT IMPLEMENTATION

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AGROFORESTRY EDUCATION FOR HIGH SCHOOL AGRICULTURE SCIENCE

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TABLE OF CONTENTS

LIST OF TABLES.....	V
LIST OF FIGURES	V
CHAPTER 1. INTRODUCTION	1
THE FOUNDATIONAL NATURE OF HIGH SCHOOL AGRICULTURAL EDUCATION	1
A RECOGNIZED NEED FOR SUSTAINABLE AGRICULTURE EDUCATION.....	2
THE EXPANSION OF AGROFORESTRY EDUCATION OPPORTUNITIES	3
REACHING THE MISSOURI HIGH SCHOOL EDUCATOR WITH AGROFORESTRY CONTENT.....	5
DEFINITION OF TERMS	9
CHAPTER 2. LITERATURE REVIEW.....	10
CURRICULUM IMPLEMENTATION: OPPORTUNITIES AND CHALLENGES	10
TEACHER LEARNING AND PROFESSIONAL DEVELOPMENT.....	13
TEACHER SELF-EFFICACY IN AGRICULTURAL EDUCATION	19
RESEARCH PURPOSE AND OBJECTIVES.....	26
CHAPTER 3. A NOVEL CONTENT IMPLEMENTATION INQUIRY.....	28
BACKGROUND AND OBJECTIVES.....	28
RESEARCH METHODS AND PROCEDURES.....	30
<i>Data analysis protocol and coding structure</i>	<i>33</i>
FINDINGS.....	36
<i>Objective 1:</i>	<i>37</i>
<i>Explore how Missouri high school agricultural educators source, learn about, modify and enact novel curriculum materials.</i>	<i>37</i>
<i>Objective 2:</i>	<i>46</i>
<i>Describe the process of novel content implementation for Missouri high school agricultural educators.....</i>	<i>46</i>
CHAPTER 4. AN AGROFORESTRY PROFESSIONAL DEVELOPMENT PROGRAM EVALUATION	51
BACKGROUND AND OBJECTIVES.....	51
RESEARCH METHODS AND PROCEDURES.....	54
<i>Data analysis protocol.....</i>	<i>58</i>
FINDINGS.....	58
<i>Objective 3:</i>	<i>59</i>
<i>Describe the demographic make up, including career experience level, of agriculture teachers participating in a short-duration PDP for novel content implementation.....</i>	<i>59</i>
<i>Objective 4:</i>	<i>61</i>
<i>Describe the change in content understanding and planned content use from attendance of the PDP.....</i>	<i>61</i>
<i>Objective 5:</i>	<i>64</i>
<i>Identify elements of the PDP, the individual teachers, their level of experience, and their teacher-learning context that may have influenced the teacher's ability to learn and to implement PDP content.</i>	<i>64</i>
CHAPTER 5. CONTENT ENACTMENT AND TEACHER SELF-EFFICACY.....	71
RESEARCH METHODS AND PROCEDURES.....	72
<i>Data analysis protocol and coding structure</i>	<i>74</i>
FINDINGS.....	77

<i>Objective 6:</i>	77
<i>Describe the variation in agriculture teacher self-efficacy among the participating teachers.</i>	77
<i>Objective 7:</i>	78
<i>Describe the variation in agroforestry content enactment achieved in the first school year following the teachers' attendance of the short-duration PDP.</i>	78
<i>Objective 8:</i>	80
<i>Evaluate the relationship between teacher self-efficacy, career experience, and agroforestry content enactment in this sample.</i>	80
<i>Objective 9:</i>	82
<i>Identify specific sources of teacher self-efficacy that may have had a significant influence on the teachers' ability to implement PDP content.</i>	82
CHAPTER 6. CONCLUSIONS AND DISCUSSION	95
INSIGHTS AT EACH STAGE OF CURRICULUM IMPLEMENTATION	95
<i>Curriculum development</i>	95
<i>Professional development program design</i>	98
<i>Content enactment</i>	100
FUTURE RESEARCH: EXTENDING THE CASE	103
LITERATURE CITED	106
APPENDICES	112
A. NOVEL CONTENT IMPLEMENTATION: TEACHER SEMI-STRUCTURED INTERVIEW QUESTIONS	112
B. NOVEL CONTENT IMPLEMENTATION: SAMPLE CLASS OBSERVATION NOTES	114
C. PROFESSIONAL DEVELOPMENT PROGRAM: AGROFORESTRY SUMMER INSTITUTE AGENDA	117
D. PROFESSIONAL DEVELOPMENT PROGRAM: PRE-TRAINING SURVEY	119
E. PROFESSIONAL DEVELOPMENT PROGRAM: POST-TRAINING SURVEY	123
F. SELF-EFFICACY: CURRICULUM IMPLEMENTATION QUESTIONNAIRE	126
G. SELF-EFFICACY: CURRICULUM IMPLEMENTATION INTERVIEW GUIDING QUESTIONS	132

LIST OF TABLES

Table 4.3 *A comparison of statewide and ASI participant (sample) agriculture teacher experience*

Table 5.1 *Experience, efficacy, and content enactment of 8 agricultural educators*

Table 5.3 *Correlations between teacher self-efficacy (TSE) constructs, enacted content hours, and experience*

LIST OF FIGURES

Figure 1.1 *Sequence of research components within the curriculum implementation case study*

Figure 2.1 *Feedback of sources of efficacy information (Tschannen-Moran, Woolfolk-Hoy and Hoy, 1998).*

Figure 2.2 *The professional development design framework (Loucks-Horsley et al., 1998).*

Figure 2.3 *Elements of a professional development system (Borko, 2004).*

Figure 3.1 *Missouri high school agriculture curriculum implementation considerations*

Figure 4.1 *Locations of teachers who attended 2016 agroforestry PDP in New Franklin, MO*

Figure 4.2 *Age and career experience of participating teachers*

Figure 4.4 *Expected growth in classroom hours for agroforestry topics: pre, post, and change*

Figure 4.5 *Change in novel content classroom hours and teacher experience*

Figure 4.6 *Average rating of factors related to Motivation to Attend*

Figure 5.2 *Expected and actual content hours enacted*

ABSTRACT

Agroforestry Education for High School Agriculture Science: A Case Study of Novel Content Implementation

Hannah Hemmelgarn

High school agriculture science programs are recognized as meaningful arenas to reach young agriculture professionals as they gain a foundational understanding of their field. Agroforestry content is largely lacking in high school agriculture science classrooms, despite its relevance to modern agricultural advancements in sustainability for economic, environmental, and social resilience. Due to the contextual nature of content adoption by agricultural educators, the curriculum implementation process for novel content is dependent on an understanding of teacher learning, teacher self-efficacy, professional development, and curriculum modification. This case study of the process of novel content implementation examines the complexities of teacher sourcing, modification, and use of novel content, evaluates an agroforestry professional development program for teachers with varying levels of experience, and follows this group of teachers one year after the professional development program to investigate the relationship between teacher self-efficacy and novel content enactment. The importance of teacher-learning support networks and experiential learning in curriculum and professional development emerged as major themes for effective novel content implementation.

Key words: Agricultural education, Curriculum, Sustainable agriculture, Teacher learning, Professional development, Teacher self-efficacy

CHAPTER 1. Introduction

The Foundational Nature of High School Agricultural Education

Agricultural education at the high school level provides a unique opportunity for equipping young agriculture professionals with a diversity of skills and knowledge in a dynamic field. Recognized as early as 1911 by G.A. Bricker in *The Teaching of Agriculture in High School*, “The subject matter of general agriculture [in high school classrooms] is very extensive, varying from the simplest nature study to the very difficult and complex original research studies along the frontiers of the science” (p.vii). This observation persists in today’s agriculture classrooms, where the agricultural advancements of recent decades must be adequately taught in order to prepare young people for careers in a modern landscape (Drape et al., 2016; NAAE, 2017).

While the number of college-educated farmers has increased substantially in the last 10 years, for the 70% of US farm operators who have not completed a college degree (USDA-ERS, 2012), the high school agriculture program and extracurricular organizations such as FFA and 4H may be among the most essential arenas of professional training. Of the 5,419 students who graduated from secondary agricultural education programs in 2014-15 in Missouri, 64% are pursuing careers in agriculture (DESE, 2016), suggesting that high school programs can both inform and inspire students in their occupational pursuits.

A Recognized Need for Sustainable Agriculture Education

Environmental, social, and economic concerns of sustainability and the increasingly global scale of agriculture are at the forefront of research and education efforts at the university level, but have not been sufficiently transferred to the high school curriculum (Agbaje et al., 2001; Alonge & Martin, 1995; Muma et al., 2010; Williams, 2000; Williams & Wise, 1997). By the 1990's, sustainable agriculture education had become a prominent theme in the Journal of Agricultural Education. The "sustainable agriculture" detailed in this early literature is exemplified by practices such as soil testing, soil erosion control, crop rotation, reduced use of chemicals, integrated pest management, and the use of cover crops (Agbaje et al., 2001; Alonge & Martin, 1995), although rarely includes mention of agroforestry practices.

Marshall and Herring (1991) noted that the inclusion of sustainable agriculture in the high school curriculum "will probably not occur, at least at the secondary level, as separate courses. Rather as units in agriculture are taught, discussion of these issues will be integrated" (p.12). Agbaje et al. (2001) also foresaw that "in regard to curriculum development, sustainable agriculture values should be infused into the philosophy for secondary school agricultural education programs and content that aligns with the new philosophy included in the curriculum" (p.43). Given the FFA overarching goal of preparing students with the competencies and leadership skills necessary to succeed in agricultural careers, where "agriculture is a dynamic, rapidly changing industry that has an exciting future", and to provide an education that "will engage students in the

globalization of agriculture as the solution for environmental demands, food safety, technology, natural resource protection, and urbanization" (FFA, "What is Agriculture Education", p.1) sustainable practices exemplified by agroforestry are well suited to meet these needs.

The Expansion of Agroforestry Education Opportunities

Despite the absence of agroforestry among the content areas identified by early sustainable agriculture education researchers, agroforestry has been identified as a sustainable land use system for more than 50 years (Bene et al., 1977). Practices associated with agroforestry integrate conservation objectives within economically viable agricultural production systems by employing combinations of trees and/or shrubs with crops and/or livestock (Somarriba, 1992). Widespread agroforestry applications have historically occurred in response to environmental and economic need. For example, following the Dust Bowl in the early 20th century in the US, farmers were encouraged to install windbreaks with the help of federal programs. In tropical regions, agroforestry practices have been promoted in response to deforestation, cultivation of highly erodible soils, and food insecurity (Nair, 1993).

Temperate agroforestry practices including alley cropping, silvopasture, riparian forest buffers, and windbreaks that reduce soil erosion and water contamination, while increasing carbon sequestration opportunities, are now recognized as a sustainable alternative to the conventional monoculture rotations widely used in the US today (Fisher, 2011; Jose & Bardhan, 2012). However, surveys of Iowa high school agriculture

teachers' and students' knowledge of 11 sustainable agriculture practices between 1993 and 2000 revealed that teachers and students consistently knew least about "agroforestry" (Williams & Wise, 1997; Wise, 1993). While more than 20 years have passed since the publication of their research, agroforestry is still missing from the realm of high school agricultural education, where sustainable agriculture content areas may serve as a source of what D'Souza et al. (1993) term an "awareness effect". Based on this idea, an awareness and understanding of the environmental factors pertaining to, and ecosystem services derived from sustainable agriculture practices such as agroforestry, increases the likelihood of their use by farm operators and landowners (D'Souza et al., 1993).

Outside of the academic agricultural education context, agroforestry outreach and education efforts have increased in scope and number for farmer-landowners and natural resource professionals with the support of domestic and international agroforestry organizations (Merwin, 1997; Jacobson & Kar, 2013). As a result, agroforestry conferences, technical trainings, and networking opportunities have enabled the expansion of programs such as the Natural Resources Conservation Service (NRCS) technical standards for agroforestry practices (MacFarland & Wight, 2015). In 2016, Missouri's NRCS became the first to offer a funding pool specifically designated for agroforestry practices within the Environmental Quality Incentives Program (EQIP) (Cartwright et al., 2017). Landowners and natural resource professionals have also benefitted from "train the trainer" type programs. The University of Missouri Center for Agroforestry's (UMCA) Agroforestry Academy is an example of this kind of program that serves as a week-long intensive to prepare attendees to apply or to assist with agroforestry planning and design. "Train the trainer" programs are valuable as an

outreach tool (Gold, 2015), yet they reach a limited demographic of those who are already inclined to discover opportunities for agroforestry applications.

In post-secondary academic settings, agroforestry education opportunities have grown incrementally in the last 20 years. In 1990, a survey of 39 Society of American Foresters accredited schools revealed that 14 offered at least one course in agroforestry, usually prompted by student interest in tropical applications of the subject (Warren & Bentley, 1990). A more recent survey of 127 post-secondary education institutions in the US found that of the 27 institutions currently offering agroforestry courses, more of these courses are now focused on temperate agroforestry practices; most offered only one agroforestry course; and 3 offered degree programs in agroforestry (Wright, 2017).

Reaching the Missouri High School Educator with Agroforestry Content

The Missouri Department of Elementary and Secondary Education's (DESE) agricultural education report establishes that cooperation with educational institutions will help to provide enhanced education programs, which advance "a dynamic and efficient agriculture, food & natural resource system" (DESE, 2015, p.1). Missouri's statewide agriculture curriculum materials are in the process of being revised after a long stagnation of content, and the University of Missouri Center for Agroforestry (UMCA) has partnered with DESE in order to capitalize on this opportunity to address the gap that exists in high school agricultural education programs where agroforestry practices are not currently being taught.

Agroforestry training materials designed for non-academic education and outreach are currently available, although the content and method of dissemination for high school teachers requires thoughtful modifications. Where seminar and farm visit training workshops on agroforestry may be effective for Extension specialists and farmer-landowners, public high school agriculture teachers may be better able to apply agroforestry teaching materials presented as lesson plans suited to national and state education standards, demonstrations of experiential programs, and resources suited for student activities, as evidenced by case studies from sustainable agriculture education curriculum development leaders (D. Mayerfeld, personal communication Jan. 25, 2016; Marie Davis, personal communication Feb. 17, 2016; Rudd & Hillison, 1995).

Unlike the non-formal and informal education provided by specialists at agroforestry centers, Cooperative Extension services, and natural resource agencies, the requisite continuous adaptation and enactment of agriculture course work at the high school level is in large part the responsibility of the high school agriculture teacher, who may have a diverse background in agriculture training, but who is charged with preparing his or her students for the most up-to-date realities of the subject area (McKim & Velez, 2016; Drape et al., 2016). The awareness cascade in the high school classroom thus begins with “teacher learning, one of the most critical targets of educational reform” (Desimone, 2009, p.181).

The opportunity for agroforestry and other sustainable agriculture technologies to be integrated into class content at this time calls for a closer look at how Missouri high school agricultural educators are involved in the process of novel content and curriculum implementation, given their unique prior teaching experiences, interpretations of

professional development preparation, and educational resources. Given the complexity and context-specific nature of each component of curriculum implementation, qualitative and mixed-methods case study approaches used in this research allow for a rich exploration of this process (Yin, 2014; Creswell, 2014). Within the broad bounded system of curriculum implementation, known factors influencing teacher learning and classroom enactment are explored, including the role of teacher self-efficacy (Tschannen-Moran et al., 1998), level of teaching experience, and qualities of a professional development program.

The significance of this research is summarized in the following set of circumstances:

- 1) A need exists for sustainable land management models in all arenas of agricultural education. The field of agroforestry meets these content criteria.
- 2) High school agriculture education is a well-established learning environment for young adults who will enter the field; however, sustainable practices, especially agroforestry, are still missing from this delivered content.
- 3) Content implementation is a complex and contextual process that requires the development of appropriate teaching materials, professional development programs, and an understanding of how the teacher's learning context is affected by his or her experiences and opportunities.

In order to facilitate the adoption of agroforestry content and further opportunities for sustainable agriculture curricula in high school agriculture science, this case study examined the content implementation process in a sequence that reflects the essential

components of implementation. The first phase of the case study employed triangulation (Yin, 2014) of semi-structured teacher interviews, class observations, and national agricultural educator forums on curriculum to inform the overall process of content sourcing, modification, and use. This initial inquiry also guided construction of teaching materials with novel content and teacher workshop organization. In the second phase of the case study, a 1-day agroforestry professional development program (known as the Agroforestry Summer Institute) is evaluated and analyzed using pre- and post-training surveys for an understanding of teacher content knowledge gained, and the expected classroom enactment achieved from the short-duration training. The third phase of the case study follows the teachers who attended the 1-day professional development program to review actual classroom enactment of the novel agroforestry content in the first year after the training, and the relationship between enactment and teacher self-efficacy. In this final phase, an exploratory sequential mixed methods approach (Creswell, 2014) was employed by pairing a validated teacher self-efficacy survey instrument (Wolf et al., 2010) with semi-structured teacher interviews. This paper is presented following this sequence of the process of novel content implementation (figure 1.1).

Figure 1.1 *Sequence of research components within content implementation case study*

DEFINITION OF TERMS

Sustainable agriculture and the practices that encompass sustainable agriculture are defined as meeting three primary goals: 1) profit over the long term, 2) stewardship of land, air, and water, and 3) quality of life for farmers, ranchers, and their communities (USDA SARE, 2012).

Agroforestry is defined as “the intentional integration of trees and shrubs into crop and animal farming systems to create environmental, economic, and social benefits” (USDA National Agroforestry Center, p.1).

Curriculum implementation is the planning for and actual use of a curriculum in practice (Kimpston & Rogers, 1986), where curriculum is the sum content and objectives of a specific program or discipline (Toombs & Tierney, 1993).

Content implementation is the planning for and actual use of a single component of a curriculum, or the teaching materials associated with a given subject area.

Teacher self-efficacy is defined as “teachers’ confidence in their ability to promote students’ learning” (Hoy, 2000, p.2), where “a teacher’s efficacy belief is a judgment of his or her capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated” (Tschannen-Moran & Hoy, 2001, p.1).

Pedagogical content knowledge (“PCK”) is “an integrated understanding that is synthesized from teacher knowledge of pedagogy, subject matter content, student characteristics, and the environmental context of learning” (Cochran, 1991, p.11),

CHAPTER 2. Literature Review

Curriculum implementation: opportunities and challenges

According to Ball and Cohen's review (1996) of the use of curriculum provided to teachers, lesson and unit materials have tremendous potential to reach teachers and students in the most intimate every day act of instruction, yet "curriculum materials have played an uneven role in practice" due to a lack of accounting for the "teacher's need to learn in order to use new materials" (p.6), their prior understanding of and beliefs about the material and its importance, and their adaptations of new curriculum to meet the needs of their students. They note that while instructional materials are used to shape what and how students learn, "the strategy is often unsuccessful, for teachers regularly reject curricular innovations" due to curriculum developers' failing to account for the role of the teacher and his or her use of new materials, the inability to anticipate what students bring to the learning experience, and the teacher's empowerment to adapt or modify materials encouraged by "the idealization of professional autonomy and American individualism" (Ball and Cohen, 1996, p.6).

In order to address this distance between the construction of curriculum materials and the use of these materials in the classroom, Ball and Cohen (1996) recommend that the curriculum developer should maximize her connection to the teachers who will use the materials so that curriculum construction can "draw on teachers' understanding and students' thinking, and...depend on engaging ways to represent the material and develop the intellectual environment of a class" (p.8). Van Den Akker (1988) mirrors this request

for nuanced understanding by suggesting that curriculum materials and professional development “allow for the variety of settings, personalities, and circumstances for which the guide is intended” (p.47).

A curriculum developed with awareness of the teacher’s learning and classroom context is still only the start of the curriculum implementation process. Fullan and Pomfret’s (1977) review of curriculum implementation research defines curriculum implementation as “the actual use of an innovation or what an innovation consists of in practice” (p.336). According to Fullan and Pomfret, implementation consists of five dimensions: changes in materials, structure, role/behavior, knowledge and understanding, and value internalization. Curriculum implementation strategies have shifted since the 1970’s, according to Cho (1998), who recognized a dichotomous divide between fidelity and adaptive implementation strategies, and suggested the relinquishing of both towards a “new constellation, where the role of the teacher can be realistically constructed in light of whose authority is most important in the classroom” (p.2).

Fidelity curriculum implementation, rooted in behaviorism and positivism, emphasizes homogenized and standardized methods, where the curriculum is used as its developers originally intended. Adaptive implementation strategies are post-positivist in that they emphasize the complexity of the context in which a change takes place, where modifications are expected based on local-oriented change process (Cho, 1998). A third, Enactment Strategy for curriculum implementation, presented by Snyder et al. (1992), suggests that curriculum implementation is a constructivist process shaped by the evolving constructs of teachers’ and students’ meaning making. Ball and Cohen (1996)

also recognized that “the curriculum that counts is the curriculum that is enacted” (p. 7), where the enacted curriculum is jointly constructed by teachers, students, and materials in particular contexts. All three of these perspectives may be represented in an agriculture classroom with respect to curriculum enactment, although the ambiguity of the sources and uses of Missouri high school agriculture curriculum materials makes this case study particularly necessary at this time, while the state’s redeveloped agriculture science curriculum is intended to be comprehensively employed.

Several elements of the curriculum implementation context have been identified as relevant to the degree of fidelity or adaptive enactment of content. In 2005, field observations of two middle school teachers’ use of a 20-lesson curriculum package and interviews with teachers were used to measure the influence of teacher beliefs on curriculum implementation (Cronin-Jones, 2006). The case study revealed four major categories of beliefs that appeared to influence curriculum implementation. Beliefs about how students learn, a teacher’s role in the classroom, the ability levels of students in a particular age group, and the relative importance of content topics all played a role in curriculum adjustments (Cronin-Jones, 2006). Gess-Newsome (1999) also reported that “differences in teachers’ beliefs and conceptions about their subject matter were directly linked to teachers’ judgments about content and were noted as a primary factor influencing planning” (p.52).

Teachers’ beliefs about their students also play a role in the enactment of teaching material content. Cusick (1983) found that curricula was often transformed, or even abandoned by teachers in an effort to keep students in school. In this case, teachers’

knowledge of their students' preparedness was a strong factor in curriculum modification. Pedagogical instruction modifications also resulted from teachers' reflection of student disinterest, where "teachers seemed to negotiate implicitly with students to... give up assigning writing in favor of fill-in-the-blank worksheets because of problems entailed in getting students to do the writing" (Cusick, 1983).

With experience, pedagogical knowledge may increase a teacher's ability to adopt novel content, but only with sufficient content knowledge. A section of Ball and McDiarmid's (1990) *Handbook of Research on Teacher Education* confirms the problem that "while teachers' knowledge about learners, the curriculum, pedagogy, and the context seems to increase from their practice, that they will learn enough about their subject matter from their teaching to shore up inadequate knowledge and understanding is unclear" (p.20). Ball and McDiarmid (1990) suggest from their synthesis of the influence of teachers' content knowledge on enacted curriculum that "researchers need to search out and investigate the various efforts to provide more effective subject matter preparation—courses, workshops, and thematic programs" (p.22).

Teacher learning and professional development

Cochran (1991) points out in her dissertation on teacher pedagogical content knowledge that from the progression of a historical focus on teachers' understanding of content, to a focus on pedagogical methods, there is a renewed recognition of the need for teacher subject matter understanding in combination with these pedagogical frameworks. Pedagogical content knowledge (PCK), defined as "an integrated understanding that is

synthesized from teacher knowledge of pedagogy, subject matter content, student characteristics, and the environmental context of learning” (Cochran, 1991, p.11), may be an important factor in the case of the introduction of agroforestry content in Missouri’s high school agriculture classes, given the expected unfamiliarity of the content. In this case, the teacher’s ability to implement an agroforestry curriculum may be dependent on his or her ability to apply agroforestry content knowledge to existing pedagogical knowledge.

Among Cochran’s (1991) conclusions is that the “development of PCK requires early, continued, and authentic field experiences with opportunities for ‘real teaching’; and follow up reflection and feedback” (p.17). She suggests that the involvement of experienced teachers in teacher preparation programs be used to achieve this need. This conclusion may also be useful for those teachers who, as in the case of redeveloped agriculture curriculum including new subject areas, have many years of experience, but must adapt their PCK to unfamiliar content. As such, Cochran also states that “PCK development continues beyond initial licensure (or certification) and should be an integral part of inservice professional development” (Cochran, 1991, p.17). Since “the high level of specificity of PCK with respect to subject matter concepts makes it difficult to determine how best to prepare teachers with a solid basis of PCK” (Cochran, 1991, p.18), case by case exploration of teacher preparation program needs are the basis of this investigation.

Shulman (1987), who is credited with the coining of “pedagogical content knowledge”, identified seven knowledge bases needed for teaching in his original inquiry of PCK. These knowledge bases include: content knowledge, pedagogical knowledge,

curricular knowledge, pedagogical content knowledge, knowledge of students, knowledge of context, and knowledge of educational goals (Shulman, 1987). He describes the sources of these knowledge bases as scholarship in content disciplines, materials and settings of the institutionalized educational process (i.e. curricula, textbooks, school structure), research on social and cultural teaching developments, and the wisdom of practice itself (Shulman, 1987). “Because teachers necessarily function within a matrix created by these elements, using and being used by them, it stands to reason that the principles, policies, and facts of their functioning comprise a major source for the knowledge base... that will either facilitate or inhibit teaching efforts” (Shulman, 1987, p.8).

Rice and Kitchel (2015) have more recently researched the influence of PCK on teacher behaviors. They described that due to the breadth of knowledge that the agriculture teacher in particular is expected to teach, a “lack of content knowledge subsequently impeded the teachers’ ability to break down content effectively for their students and resulted in various coping mechanisms being utilized when teachers felt deficient in content” (p.91). A lack of content knowledge indicated a concomitant lack of PCK, making it difficult for teachers to “generate new explanations, representations, or clarify materials to students” (Rice & Kitchel, 2015, p.92; Shulman, 1987). Grossman’s *The Making of a Teacher: Teacher Knowledge and Teacher Education* (1990) outlines four sources of PCK development: disciplinary education, observation of classes, classroom teaching experiences, and specific courses or workshops, where classroom experience has the strongest effect.

In addition to a teacher's own experiences and in-school evaluations, professional development programs serve as ongoing sources of structured learning for teachers throughout their careers. Effective professional development programs (PDP) are seen as an essential mechanism of content and pedagogy reform (Diaz-Maggioli, 2004; Little, 1993), where "it is necessary to reposition professional development so that the collective efforts of teachers, students, and administrators result in enhanced learning for all members of the teaching community" (Diaz-Maggioli, 2004, p.1). Yet the substantial amount of research on effective professional development approaches provides only partial solutions to the question of what may ensure curriculum implementation outcomes. Given a common high-quality professional development experience, "teachers vary considerably in what they learn and how they translate that knowledge into practice, and we do not know as much as we should about why this variation occurs" (Covay Minor et al., 2016, p.3). However, research that has been done on PDP outcomes consistently suggests an increasing focus on continuous, collaborative, teacher-centered approaches (Diaz-Maggioli, 2004; Little, 1993; Loucks-Horsley et al., 1998; Garet et al., 2001).

Stumbling blocks to effective professional development for educators may include top-down decision-making that excludes educators from the process of problem-solving; lack of ownership of the professional development process and its results; a lack of variety in instruction methods; the need to invest considerable effort into translating the materials into unique classrooms; inaccessibility of professional development programs; lack of support in transferring development ideas to the classroom; standardized approaches to professional development that disregard the varied needs and

experiences of teachers; disregard for the learning characteristics of teachers, and lack of systematic evaluation of professional development (Diaz-Maggioli, 2004). The complexities of planning and enacting an effective PDP are numerous, but as more is understood about what works for some teachers differently than others, meeting the needs of diverse teachers as learners becomes more feasible. “Visionary professional development” according to Diaz-Maggioli (2004), includes collaborative decision-making, a growth-driven approach, inquiry-based ideas, varied and timely delivery methods, adequate support systems, and proactive assessment.

While the content and organization of professional development programs may be directed toward certain outcomes, teachers have critical agency in development and delivery of content for student understanding (Ben-Peretz, 1975). “What teachers know and can do is the most important influence on what students learn” according to Darling-Hammond (1996, p.10). The agroforestry curriculum provided to the teachers in this case study includes detailed lesson plans that mirror a familiar format, although curriculum fidelity varies following content PDP (Covay Minor et al., 2016). This curriculum was designed to meet the standard Diaz-Maggioli (2004) describes as having “a dialogic perspective” where “the teacher’s learning style is open to interaction and the exercise of greater freedom” (p.9). Curriculum development efforts for “Next Generation Science Standards” have been equally steered towards building “a framework to operate and engage students in their own learning instead of rote memorization” (NGSS, 2013). The problem-solving, project-based activities presented in the Agroforestry Summer Institute PDP and agroforestry teaching materials are designed for mutual student and teacher exploration, with an aim to promote responsibility for learning.

Engaging materials have become a priority in recent years based on inquiry-based education concepts, alongside extensive research on the effectiveness of experiential and peer-led education methods. Preszler (2009) documented the impact of including peer-facilitated workshops in an introductory high school biology course, noting that his students showed “enhanced interactivity” and “increased student engagement and learning” (p.1). Students who attended two lectures and one problem-solving workshop in the week, instead of three lectures, scored higher on exams that included higher-level thinking, and showed the most improved grades among females and underrepresented minorities (Preszler, 2009). Problem-solving skills are emphasized in agricultural education in order to “prepare conservation practitioners with critical skills in values-setting, working with decision makers and stakeholders, and effective problem framing” (Johnson et al., 2015, p.1).

While an experiential approach may be ideal for enhanced learning opportunities, teachers are also charged with selecting, sequencing, organizing, planning, delivering, and evaluating their students’ understanding (Diaz-Maggioli, 2004). One concern regarding the implementation of agroforestry content relates to the absence of some components of the curriculum content from state tests, since highly competitive agriculture testing may prompt a teacher to teach to the test at the expense of other formational tasks (Freire, 1998). Ben-Peretz (1975) mirrors the statement of limited control over curriculum use; “once curriculum materials have left the originators’ hands they may be interpreted and used in many ways. Curriculum may be seen as the embodiment of a potential, independent of its developers’ intentions” (p.151). She calls this concept “curriculum potential”, referring to “the notion of a wide range of possible

learning outcomes that result from various interpretations of curriculum” (Ben-Peretz, 1975, p.152).

Drape et al. (2016) also express that an educator’s success, and therefore student success, is not only dependent on effective professional development programs, but also on personality characteristics of the teacher, affirmation from administrators, and level of experience. Curriculum implementation may thus be particularly challenging for beginning agriculture teachers who, according to Myers et al. (2005) and Kopkowski (2008), are more likely to leave within the first five years of their careers, when peer and administrator support could have a profound impact on their beliefs about their abilities as educators to persist and learn.

Teacher Self-Efficacy in Agricultural Education

The construct of teacher self-efficacy (Tschannen-Moran et al., 1998) is derived from Bandura’s social cognitive theory (1977), which describes “self-efficacy” as “people’s beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives” (p.1). The application of self-efficacy theory to the world of educators, called “teacher self-efficacy,” is recognized as a critical component of teacher learning and student achievement, content adoption, and professional development of teachers in their early years of teaching (Wolf et al., 2010; Woolfolk, 2007). What Covay Minor et al. (2016) describe as the mechanisms necessary for translating content knowledge into instruction, “including increased confidence,

willingness to ask higher questions, proclivity to experiment, ability to identify student mistakes, and many others” (p.3), may also be described as behaviors associated with a high level of teacher self-efficacy. A curriculum’s potential and PDP teacher outcomes may therefore largely be related to teacher self-efficacy, which is closely tied to the struggles of beginning agriculture teachers who may lack the experience to propel their confidence in adopting new strategies and content.

What promotes teacher self-efficacy? Tschannen-Moran et al. (1998) reiterate Bandura’s sources of efficacy as verbal persuasion, vicarious experience, physiological arousal, and mastery of experience, which combine to create positive efficacy information feedback (figure 2.1). These components of teacher self-efficacy align with the suggested modifications to professional development and curriculum implementation, where verbal persuasion is fulfilled through administrative support, peer observation provides vicarious experience, and successful teaching experiences may bring about physiological arousal and mastery.

According to Drape et al. (2016), “the challenges associated with teaching a diverse set of curricula in an agriculture education program are many and efficacy can play a key role in how the teacher feels about their work, their ability to teach numerous subjects, and their persistence in learning new instructional methods after they’ve begun their career” (p.36). Klassen and Chiu’s (2010) study of three domains of teacher self-efficacy (instructional strategies, classroom management, and student engagement) revealed that teachers with greater classroom stress had lower self-efficacy, highlighting again the limiting variables associated with PDP classroom instruction outcomes. Ultimately, as Drape et al. (2016) points out, a one-size-fits-all approach to professional

development may not be effective.

Figure 2.1 *Feedback of sources of efficacy information* (Tschannen-Moran, Woolfolk Hoy and Hoy, 1998).

Covay Minor et al. (2016) found that teachers “used professional development to fit their needs, depending on their previous content knowledge in the subject” (p.21). Their study of teachers with varying levels of content knowledge in content-only and content-plus-pedagogy interventions revealed that those with strong prior content knowledge gained more substantial pedagogical content knowledge, whereas those with weak prior content knowledge gained confidence with their understanding of the material (but less PCK) (Covay Minor et al., 2016). Their work, along with several others, echoes what Diaz-Maggioli (2004) recommends, that “building teachers’ content knowledge in meaningful ways requires sustained, content-focused professional development that is embedded in teachers’ work lives and that allows for practice, discussion, and feedback” (Covay Minor et al., 2016, p.3), so that teacher learning is enhanced by focus on content knowledge and opportunities for active learning in a sustained community of educators (Garet et al., 2001; Ingvarson et al., 2005).

In addition to the impact of a teacher’s level of experience, peer and administrator support affect the outcomes of professional development for both content and pedagogy, and ultimately teacher self-efficacy. Given that “teachers’ learning experiences, in combination with a host of contextual and personal factors, drive what teachers know and do” (Covay Minor et al., 2016, p.4), there is a degree of uncertainty to the impact of professional development on teacher understanding and behavior outcomes. However, it is in the best interest of teachers, students, curriculum and PDP developers to identify

what works well and what requires modification in any given community of educators. Loucks-Horsley et al. (1998) point out that “outstanding professional development is complex, combines different elements and strategies at different times, and is continuously evolving and changing” (p.6). Their model of professional

Figure 2.2 The professional development design framework (Loucks-Horsley et al., 1998).

development is an adaptive approach that considers the specific context and players that define the knowledge and beliefs guiding the program’s goals (Figure 2.2).

Borko (2004) describes the elements of a professional development system (Figure 2.3) as containing the professional development program itself, the teachers who are the learners in the system, the facilitator who guides teachers as they construct new knowledge, and the teacher-learning context in which the professional development occurs. To date, teacher professional development research has focused on the effective

Figure 2.3 *Elements of a professional development system* (Borko, 2004).

sustainable agriculture content changes.

Still, studies regarding teacher professional development have contributed to an understanding of how elements of a PDP may affect teacher learning during a single PDP event. One critical PDP element identified by Supovitz and Turner (2000), and further highlighted by Desimone (2009) is the duration of the program, where a long-duration or extended sequence of professional development results in a more lasting effect on teacher learning and implementation. Unfortunately, long-duration programs, defined as one week or more, are often not accessible to teachers whose schedules or budgets are limited. Professional development program accessibility is explored in the first component of this sequenced research.

An understanding of the sources of teacher self-efficacy in agricultural education has also played an important role in the exploration of the plurality of experiences that constitutes the teacher-learning context (McKim & Velez, 2016). According to Drape et al. (2016), “the challenges associated with teaching a diverse set of curricula in an

¹ A definition of “teacher-learning context” is based on Borko’s (2004) statement that “for teachers, learning occurs in many different aspects of practice, including their classrooms, their school communities, and professional development courses or workshops” (p.4)

agriculture education program are many and efficacy can play a key role in how the teacher feels about their work, their ability to teach numerous subjects, and their persistence in learning new instructional methods after they've begun their career" (p.36).

Sources of teacher self-efficacy, including mastery experiences, vicarious experiences, social persuasion, and physiological and emotional states (Tschannen-Moran et al., 1998), are not equal in weight. Research on early-career teacher professional development indicates that, while mastery experiences such as peer teaching can be most profound when the outcome of the practiced behavior is successful (Knobloch, 2001), vicarious experiences such as teacher observation, and the social persuasion of positive feedback from superiors, can be more effective at generating early-career teacher self-efficacy (Wolf et. Al., 2010). The research that has been done on this subject is limited, and has been more focused on preservice and early teaching experience than mid- and late-career teaching sources of sustained self-efficacy (McKim & Velez, 2016).

However, Drape et al.'s (2016) case study of 2 mid-career agriculture teachers also identifies that "efficacy was a major factor in the teacher's ability to incorporate other subject matter in class" (p.44). Career experience may in fact be related to changes over time in teacher self-efficacy, as was found in Klassen and Chiu's (2010) study establishing that while teacher self-efficacy increases as teachers move from early to mid-career, it may decline as teachers near the end of their careers.

Based on McKim and Velez's (2016) evaluation of the research that has been conducted within agricultural education on teacher self-efficacy, including 30 studies published between 1997 and 2013, they suggest that an exploration of self-efficacy development related to professional development opportunities throughout the agriculture

teaching career should be a focus of future research. By exploring the relationship between self-efficacy levels of teachers who have a wide range of career experience, and the degree that they implement agroforestry content from a short-duration PDP, an understanding of how best to address self-efficacy growth and professional development applications for sustainable agriculture content implementation in high school agriculture classes may emerge.

Curriculum implementation concepts that have been previously explored were used as a guide for the direction of this case study, wherein pedagogical content knowledge is accounted for in the design of the agroforestry teaching materials and PDP, teacher-learning and the teacher-centered approach to professional development were considered in the execution of the 2016 Agroforestry Summer Institute, and the teacher's ongoing experience, self-efficacy, and classroom context were further explored in the novel content implementation inquiry and one-year follow-up with teachers who attended the agroforestry PDP. The University of Missouri Center for Agroforestry may in this way serve as an example for other sustainable agriculture institutions that seek to improve upon the agriculture science curriculum presented in the high school setting.

This exploratory case study of the process of agroforestry content implementation among a diverse group of Missouri high school agricultural educators is designed using a pragmatic structured, post-positivist approach based on Yin's systematic method, including triangulation of data from interviews, document analysis, and observation describing the plurality of experiences within the case (Yin, 2014). Additionally, survey instruments were used to describe teacher demographics and to measure teacher

understanding and teacher self-efficacy in conjunction with the rich descriptions provided by teachers in interviews, following the guidelines for validity and reliability of an explanatory sequential mixed methods approach (Creswell, 2014). Epistemological assumptions inform this approach, as exemplified by Beers (1988) who argues that “while epistemological issues are rarely made explicit in classrooms, they are implicitly represented in the organization and content of curriculum, in the interaction between teachers and students, and in the nature of classroom activity and discourse” (Beers, 1988, p.87).

RESEARCH PURPOSE and OBJECTIVES

The central purpose of this research is to explore the process of novel sustainable agriculture (agroforestry) content implementation for high school agricultural educators in Missouri, by analyzing the experiences of a group of educators in relation to components of the content implementation process.

Objectives of the research are to:

I. A Novel Content Implementation Inquiry:

- 1) Explore how Missouri high school agricultural educators source, learn about, modify and enact novel curriculum materials;
- 2) Describe the process of novel content implementation for Missouri high school agricultural educators;

II. An Agroforestry Professional Development Program Evaluation

- 3) Describe the demographic make up, including career experience level, of agricultural educators participating in a short-duration agroforestry professional development program (PDP) for novel content implementation;
- 4) Describe the change in content understanding and planned content use from attendance of the PDP;
- 5) Identify elements of the PDP, the individual teachers, their level of experience, and their teacher-learning context that may have influenced the teacher's ability to learn and intention to implement PDP content;

III. Content Enactment and Teacher Self-Efficacy

- 6) Describe the variation in agricultural educator self-efficacy among the participating teachers;
- 7) Describe the variation in agroforestry content enactment achieved in the first school year following the teachers' attendance of the short-duration PDP;
- 8) Evaluate the relationship between teacher self-efficacy, career experience, and agroforestry content enactment in this sample;
- 9) Identify specific sources of teacher self-efficacy that may have had a significant influence on the teachers' ability to implement PDP content.

CHAPTER 3. A Novel Content Implementation Inquiry

Background and objectives

Prior analyses of the relationship between teachers, materials, and curriculum construction has indicated that curriculum materials are often intended to meet common standards in diverse settings, despite unique circumstances in each school, district, and classroom. The agroforestry teaching materials proposed by UMCA for use in Missouri public high schools are intended to make agroforestry content as relevant and accessible as possible for the teachers and classroom settings for which the materials will be provided. For this reason, it is important for curriculum developers to have a prior understanding of teachers' unique experiences and behaviors with new curriculum materials or subject areas. By conducting an in-depth case study of Missouri agriculture teachers' sourcing, use or modification of, and confidence with new content in teaching materials, the Center for Agroforestry, FFA and others who develop agriculture curriculum materials and teacher trainings will be better suited to create meaningful teaching materials that enable teacher implementation and student engagement in the quickly advancing field of agriculture.

This exploratory collective case study served as an inquiry into the overall process of agricultural educator curriculum implementation. Teacher interviews, classroom observations, and communities of practice forums were analyzed in order to understand how high school agricultural educators source, learn the content of, modify and enact new curriculum materials. This broad exploration of the sequence and elements of curriculum implementation for some of Missouri's agricultural educators informed the development of agroforestry teaching materials and an agroforestry professional development program, and is intended to inform the kinds of ongoing support that teachers may need in order to begin incorporating agroforestry, and other sustainable agriculture content, into their agriculture science classes.

While state curriculum for agriculture classes is provided to teachers at no cost in Missouri, it is unclear what content is actually being taught, how teaching materials are being modified, and for what purpose. The Instructional Materials Laboratory (IML) agriculture curricula (formerly developed at the University of Missouri, 1962-2012), in addition to an FFA agriculture business curriculum referred to in this research, are the primary content of current state agricultural education materials. While sustainable agriculture practices such as agroforestry will be entering the state's updated curriculum materials, to ensure that this content is enacted requires an investigation of multiple scenarios where high school agriculture teachers have had experience sourcing new materials, attending trainings for novel content knowledge, and applying these materials to their class lessons. Literature related to teacher pedagogical content knowledge and curriculum implementation indicates that teacher beliefs, content knowledge, self-efficacy, and perceived role as innovators may impact the enactment of subject-specific

lessons (Ball & McDiarmid, 1990; Ball & Cohen, 1996; Cronin-Jones, 2006; Gess-Newsome, 1999; Cusick, 1983).

For those researching and developing novel content in curriculum for agricultural educators, a better understanding of the question *how (and why) do Missouri's agricultural educators implement new curriculum materials?* may assist the process of outreach and training for educators as new resources emerge. Sub-questions that support this inquiry include: where do these educators source curriculum materials and the content knowledge needed to use this in their classes? What effective or ineffective experiences have these educators had in their efforts to gain familiarity with a new subject area? And how might these educators' enacted lessons differ from the curriculum materials the lessons represent?

Objectives of this component of the research are to:

- 1) *Explore how Missouri high school agricultural educators source, learn about, modify and enact novel curriculum materials; and to*
- 2) *Describe the process of novel content implementation for Missouri high school agricultural educators;*

Research methods and procedures

Over the course of this case study inquiry, 3 public high school agriculture teachers in Missouri participated in a semi-structured one-on-one interview in person at a convenient public library or over the phone; 20 conversation threads associated with curriculum on the National Association of Agricultural Educators (NAAE) Communities

of Practice online form were analyzed for themes that overlap with or are unique from interviews; and 2 high school agriculture classes were observed from a participant observer perspective to identify classroom context components of curriculum implementation. The interview protocol was designed to engage educators in a conversation that may reveal general themes about their experiences sourcing new curriculum materials, gaining familiarity with those new materials, and their process of implementing new content and materials (see Appendix A for the list of semi-structured interview questions).

Using a purposeful sampling strategy, educator interview participants were selected based on researcher access, diverse demographic perspectives (for maximum variation), and their ability to inform the research of curriculum innovation and implementation experiences (Creswell, 2013). Forestry extension educator, Dr. Hank Stelzer, assisted with identification of Missouri public high school agricultural educators who meet the aforementioned criteria and who have at least 2 years experience as an agriculture and/or forestry public school educator based on his familiarity with the educators in each district and his access to their contact information. Educators selected included both men and women, in rural and urban counties, and with a range of 6-22 years of teaching experience, representing 3 of the 6 FFA state regions. From the initial 3 interviews, emerging categories and themes have been consistent between educators and between other triangulated sources (NAAE forums and class observations), suggesting data saturation (Creswell, 2013).

The educators who participated in the initial phase of this study's semi-structured interviews included one female with 6 years of teaching experience in a peri-urban high

school, one male with 10 years teaching experience in a rural high school, and one male with 22 years experience teaching at a rural high school. The variation in experience level was of particular interest for comparing curriculum implementation habits. Urban-rural contexts also revealed variation in resource access and student demographic impacts on curriculum use and professional development program access. Each educator interviewed has been assigned a number, referred to as Teacher 1 (male with 22 years experience), Teacher 2 (female with 6 years experience), and Teacher 3 (male with 10 years experience) in order to ensure anonymity.

The NAAE Communities of Practice online forum is a professional network of agricultural educators throughout the US, whose stated purpose is “to create a common place for anyone who is interested in agricultural education to share ideas and resources” (NAAE, 2016). As such, it represents a broader picture of educator voices. Using the Communities of Practice forum search tool, a search of conversation threads related to “curriculum” revealed over 500 results. An analysis of the first 20 conversation threads, using a similar process that was used to define codes and themes in interview transcripts, were used to provide a sample sufficient to saturate codes informing the research question. Information about the users of the forum is limited to their name, title, and the date they joined the online network. While this information does not inform the criteria used for interview participant selection (i.e. years of experience, rural/urban school), the majority of the threads analyzed were initiated by educators who self-reported being in their first year of teaching (>50%), or teaching a class for the first time (25%).

Just as NAAE Communities of Practice document analysis helped to confirm and broaden themes identified in educator interviews, observations of agriculture high school

class lessons verified the implications of classroom resources, student and teacher behaviors, and pedagogical components of curriculum implementation. Classroom observations took place in one urban and one rural setting in Missouri, with teachers representing first year and mid-career experience levels. A sample classroom observation sheet, coded for existing and emergent themes is provided in the appendix. During class observations, noted from a participant observer perspective, focus was given to the time allotted to various class activities (e.g. lecture, written assignment, or peer-learning), student level of participation in these activities, and the resources with which students engaged during the class period. Qualitative data from these observations was analyzed by identifying patterns in teacher pedagogy and student responses, and relating these patterns to findings from teacher interviews and online NAAE forum discussions.

Together, these three sources of data triangulate lines of inquiry in order to strengthen the validity of the findings (Yin, 2014). While research participants (Missouri public high school agricultural educators) represent a narrow scope due to the focused application of the results for use toward Missouri high school agroforestry curriculum development, the national scale of the document analysis may unearth more generalizable themes.

Data analysis protocol and coding structure

The process of data analysis for the agricultural educator interviews, Communities of Practice online discussion thread documents, and high school agriculture class observations consisted of several steps. Directly following each of the interviews and class observations, reflective memos document initial impressions of the

conversation/ observation and any components of the experience that stood out as particularly important or unexpected in regards to the research questions. Following each interview or observation, these researcher memos were used as initial formation of analysis. Researcher reflexivity throughout the study enabled acknowledgement of biases, thoughtful analysis, and bracketing of prior conceptions (Creswell, 2013).

Following the transcribing of interviews, notation of document components, or review of observation notes, I used an open coding process of reading through the documents or transcriptions multiple times, underlining, highlighting and commenting on parts of these conversations based on their relevance to (1) the process of educator motivation to pursue innovative curriculum materials, (2) educator sourcing, use and modification of curriculum materials, and (3) educator training or professional development considerations related to content knowledge growth for classroom applications, based on the emergent process of curriculum implementation revealed in the documents and interviews. Each of these areas directly relates to the process by which agroforestry curriculum and content knowledge adoption will be approached, and so special attention was given to the educator voice referring to previously unknown content knowledge applied to their teaching of high school agriculture classes. Transcribed interviews were reviewed for meaning, coded based on those units of meaning, and a subsequent axial coding process involved categorization of initial codes in order to draw relevant themes from the gathered data. Likewise, observation and document notes were organized using codes that emerged from interviews, with additional codes based on unique elements from both documents and observations.

Based on meaningful sections of the transcriptions, document and observation notes, I identified the following codes, assigning each a unique text color or highlighted color in order to easily identify which passages were associated with each code, and count the codes based on their colored identifier. Under each set of codes is a reduced category indicated with “>” identified during the process of axial coding (Creswell, 2013).

(1) Educator motivation to pursue curricular materials:

First year teaching

Teaching a (new) class for the first time

Rewriting an existing curriculum to meet specific student/ teacher/ school needs

> Content areas that are new to the educator

Seeking more engaging materials/ more hands-on approach

Need for updated materials where others are outdated

> Outdated or “dry”/ text-based curriculum modification for student engagement

Discomfort or anxiety about writing or finding materials

> Urgency to source and integrate materials as lessons

(2) Educator sourcing, use and modification of curriculum materials:

Expense of materials is limiting

Online sources: Communities of Practice or Google searches

Local or regional human resources from agencies or businesses

Corporate sources

State or national education sources

>Use based on convenience (expense and access)

Creative inclusion of hands-on labs and computer use

>Ensuring that lessons are engaging and up-to-date

(3) Educator training or professional development considerations related to content knowledge growth for classroom applications:

Expense of training tuition fee, room and board

Distance and travel time for trainings

Duration of training and efficiency of time use

>Time and money cost (often the responsibility of the educator)

Print materials vs. hands-on training activities (classroom applicability)

>Experiences that mimic class experience for direct transfer to lessons

Using these codes, categories, and reflective memos, themes were identified based on the relative frequency of each code and the degree to which it was stressed in the interview, document, or observation. Verification of the emerging themes was confirmed with the educators interviewed and observed for this project. Triangulation between observation, document, and interview analysis also provide truth-value based on consistency of these codes.

Findings

Objective 1:

Explore how Missouri high school agricultural educators source, learn about, modify and enact novel curriculum materials.

The strongest concepts within each of the sources (interviews, observations, and documents) and each component of analysis (motivation to pursue new materials, sourcing, use and modification of materials, and training/ professional development for content knowledge of materials) formed the themes that respond to the research question: “How do Missouri’s agriculture and forestry educators implement new curriculum materials?” Where “new” curriculum may mean that it is new to the educator (i.e. he or she has not had formal education on this content area), or it is new to the educator’s classroom (i.e. not previously taught). The agroforestry content for which this research is applied meets both of these qualifications of “new materials”. Part of this question is also “*Why* do teachers integrate new curriculum materials?” what motivates, limits, or discourages an educator to seek and use new content knowledge? In every phase of new content implementation including 1) the educator’s perceived need for new materials or content, 2) his or her sourcing of those materials, 3) growth of content knowledge in order to modify and use the materials, and 4) use of the materials in the classroom, the following themes emerged:

- 1) Cost of materials and training is one of the most influential factors in an agricultural educator’s ability to source new materials, gain new content knowledge, and implement new curricula.

Available funding is in part related to the size of the school (urban schools with a large student body and schools with a wealthier student body are more likely to have available funds), the size of the agriculture program at the school, and competitiveness of grants or scholarships for educator trainings. Teacher 1 exemplified this limitation, “I was trying to get into CASE [Curriculum for Agricultural Science Education professional development program] a couple years ago, and the school kind of scoffed at the cost of it. I’d like to attend the training because I think it’d be really beneficial, but we haven’t found a way to pay for it yet.” CASE is a highly regarded program offered at the University of Missouri that presents an entire year of teaching materials in a two-week professional development program, and costs upwards of \$2,000. He had applied for several corporate grants to pay for part of the two-week CASE training, but hadn’t been successful in receiving those funds. Teacher 2 mirrored this sentiment, “CASE does have wonderful curriculum, but if you’re from a small school, they can have all the wonderful curriculum they want; your school is not going to have the money to send you there. I would’ve never gone to a CASE training if I hadn’t moved here.”

The cost of trainings is also related to their duration. Teacher 2 described, “The shorter time trainings are more popular because teachers don’t have the finances to stay a long time. Your summers are really really busy, and some schools don’t pay for professional development like that at all, so it is literally all out of the teachers pocket. What teacher wants to pay for a hotel room, you know?” Two or three day trainings were considered, by all the teachers, to be the most preferable training duration based on affordability, time away from home and family over the summer, and experiences with the efficiency of time use during the training.

Expense, at every level of new curriculum implementation, was expressed as either a limitation (more frequently), or an opportunity (twice in 20 Communities of Practice posts). Resourcefulness of educators who recognize the value of curricular innovation and lifelong educator learning is also clear from the extent to which online Google searches are used in order to continuously accumulate updated and engaging materials and content knowledge. Teacher 1 explained, “I look for ways to get updated materials without going through the expense of buying new textbooks every five years. I don’t do everything out of textbooks, but the updated materials and ways to access that easily is a challenge for me. We’ve got a small ag department and I’m a single teacher of the ag program here, so finding resources that are fairly inexpensive is generally a priority on my end.” In this case, as is likely for other agriculture educators in rural counties, the use of textbooks, despite being admittedly less engaging for students, is a tool when resources do not allow for expansion of educator materials.

The resourcefulness of educators is also visible in their use of local or regional agencies, business’ human resources and free materials. The Missouri Department of Conservation and “producer groups” were cited as go-to sources for free materials and visiting class speakers, in addition to “area instructors” who might share curriculum they’ve developed or have acquired over their careers. The NAAE Communities of Practice is a prime example of the value educators find in the exchange of materials. Teacher 2 explained the universality of this need for affordable, accessible materials and content knowledge as an agricultural educator: “There are a lot of ag teachers out there, especially young teachers barely keeping their head above water, because there is no way

that your college education is going to provide you all the content knowledge that you need to know for ag teaching.”

2) Educators are highly motivated to engage their students with hands-on activities, labs, and reduced text reading. Likewise, experiential learning makes for more effective growth of educator content knowledge.

In all of the research sources, engaging, hands-on, or experiential pedagogy played a role in the motivation to use, usefulness, modification and use of new curriculum materials. Motivated by student enthusiasm for learning, an educator’s ability to engage students in the class content was a unanimously important aspect of effective curriculum, and where lacking, modifications to curriculum materials were seen as essential to the educator’s ability to learn alongside his or her students as they explore new content together. Teacher 2, who had been teaching for 6 years, highlighted this point. “Project-based learning does help when you don’t know as much about [the topic] because as the kids are exploring, you are learning. It’s not meant to be a cop out; it does definitely help you progress... It takes a little bit of the pressure off you as the teacher, and you kind of get to explore as you go.” Given the breadth of agriculture topics an educator is expected to teach, even in the middle of his or her career, educators benefit considerably from the use of hands-on, problem solving lessons, and the students also seem to enjoy learning using this method.

Similarly, when asked about the most useful or beneficial aspects of formal curriculum training events, these educators all emphasized the hands-on practice as enabling them to apply the materials effectively in their classes. Teacher 3 explained, “The best thing that you can get from those workshops are things that you can take home,

for example I went to an electrical one and we built a wiring board that could be used as a demo board in class... [In another], we were actually out in the woods practicing the ID ourselves just like our students would have to learn. That was helpful for me because I didn't have a lot of knowledge like that. I'm just like a student, I don't like sitting in the classroom." The usefulness of experiential components for a teacher's ability to use materials and trainings for growth of pedagogical content knowledge was also emphasized by Teacher 2's statement, "There's plenty of knowledge out there; I can read a textbook. I need the teaching method behind it so I can make it interesting to a student. So, if you just recreate the wheel by providing me a text, that will do me no good, it won't be used. It has to be, 'hey, this is the activity that you can do, this is the project that you can assign.' That's what would make me use it or not."

Also supporting the importance placed on activity-based curriculum, textbook use and "the traditional way of teaching" was considered outdated, "dry", and difficult for students to feel motivated to achieve. An experienced educator replying to a beginning agricultural educator on the NAAE Communities of Practice forum recommended, "Try to steer away from textbooks and the 'traditional' curriculum towards one that is more engaging for students and involves them in an inquiry-based, problem-solving collaborative framework." Teacher 2 reiterates this concept, "IML especially is like this- you read and then you answer questions; horribly dry. So I will take that and I will try to either make it project-based, or it's got to be hands on somewhere... They're not going to read the textbook. So the more reading and the less activities, the less useful the curriculum is going to be. They need to be up, they need to be doing stuff,

experimenting, figuring it out on their own.” In this case, the teacher’s ability to use the teaching materials is dependent on his pedagogical knowledge.

However, due to the limitations of access or funding for physical resources that might support more hands-on activities and regional human resources (agency, business, or farm representatives), in conjunction with the availability of school textbooks and the ease with which content (for teacher and student learning) and reading or writing assignments may be drawn from texts, the use of textbooks in agriculture classrooms remains one tool, though slowly diminishing in the place of online resources, used by educators for curriculum development. Surprisingly, students seem to be more willing to read and engage with text-based learning on computers. An observation of a 1.5-hour agriculture high school class revealed that a majority of class time was spent on the computer, researching and reading in order to complete a written assignment. The educators I spoke with also expressed interest in greater use of computer-based activities, although these activities often involve extensive reading. Perhaps the research element, and the “hands-on” feel of practicing computer skills for “real world applications” makes this kind of reading assignment more engaging for students. The availability of computers in the classroom is also a resource that educators are likely to use due to the extent of information available to students at no extra cost, where computers have already been purchased.

The experiential component is also projected into Career Development Events and Supervised Agricultural Experience Program, which was referenced by all three teachers as a guide and motivator of their curriculum. Teacher 2 in fact was motivated by her own high school interest in the Career Development Event to eventually become an

agriculture educator. This teacher stressed her enjoyment of the CDE program, and use of CDE tests to guide her curriculum: “I have the natural resources class, I’ve started to add forestry in and actually this year is the first time I really studied the career development event, and it’s pretty fun.” She also referenced the competitive nature of FFA and CDE programs in agriculture classes; this also motivates her students to learn independently.

3) Access to, and use of curriculum materials, whether from a local in-person exchange, an online search, or state-provided materials, is a function of convenience (available time, awareness of available resources) and interest, which may be influenced by educator age and experience.

As mentioned in the theme of financial cost impacts on curriculum implementation, access to funding, in addition to availability of time, whether an educator is paid for his or her growth of content knowledge time (e.g. at a curriculum training, which sometimes last 2 weeks, or after school hours of research), and schedule availability for such endeavors encourage the use of materials that are most accessible and affordable (online, provided by a corporate sponsor, state education agency, or the teacher’s school). “How do you become familiar with any of it? You use your resources that you have. You have IML, you have Communities of Practice, we have some CASE curriculums that guide into it a little bit. So really, it was all about finding things that I enjoy as a teacher, and that were subject-specific and putting those in.”

One observed aspect of this accessibility is the difference between older and younger teachers in relation to their comfort using online discussion forums. The educators that mentioned the National Association of Agricultural Educators (NAAE) Communities of Practice forum, where curriculum materials and other creative ideas are

exchanged, were the significantly younger educators with many fewer years of experience. Based on my document analysis of this online community, it is likely to have provided them a supportive network of similarly young and eager educators searching to soak up a plethora of materials from which to build a program unique to their teaching methods and students, where a smaller number of more experienced educators (repeated post profiles) offered their accumulated resources. Likewise, older educators may be comfortable with the curriculum they're familiar with using, and less likely to adopt new materials or gain new content knowledge; however, this is primarily supported by the observation that the older educator interviewed was more comfortable using a textbook as a primary tool in the classroom, and that he did not mention the use of NAAE Communities of Practice, and where NAAE forums are populated by a large number of young teachers. More extensive data and analysis would be needed to confirm this observation.

All of the educators emphasized that the IML curriculum materials are very outdated, motivating them to seek new information online and from local agency and agricultural business employees, and to refer to the IML curriculum as a guide for what topics to cover rather than as a primary curriculum source. These educators also seek and implement materials that enable greater use of computers in the classroom. As mentioned in relation to hands-on activities, this may also speak to the updating of classroom lesson materials given the availability of student computers, student comfort using computers, and the preparation for use of computers in off-farm and on-farm agricultural careers. Educators have also updated their curriculum sourcing techniques to a heavy reliance on online, freely distributed curriculum materials. Nearly all of the

curriculum discussion threads in the NAAE Communities of Practice documents included links to curriculum materials. Ultimately the convenience (time, access/ availability, cost, awareness) of materials is the path of least resistance for an educator to gain the needed content knowledge given a full schedule. “It’s about knowing what resources I have online, in the school, it’s looking at those resources, reading them, studying them, and then coming up with, and kind of picking the knowledge that I think they’re going to need.”

An educator’s interest in a particular subject, as explained by Teacher 3, does enable the teacher to go into greater depth in class, and be more creative with curriculum materials based on his or her content knowledge. “The things that you enjoy are going to be the things that you focus on the most and spend the most time on just naturally.” This is confirmed by Gess-Newsome (1999) who also found that educator interests are among the factors influencing an educator’s lesson planning process.

When asked about what content knowledge each educator felt strongest teaching, their early experiences and education, from high school FFA activities or growing up on a certain kind of farm, played a significant role in their focus area of expertise and enjoyment; however, Teacher 2 pointed out the discrepancy between informal and formal education applications in her pedagogical content knowledge. While she mentioned knowing less about natural resources and needing to study the Career Development test in order to gain content knowledge about the subject, a class she taught for the first time this year, she also mentioned “When I grew up, I was definitely into the natural resources, the hunting, the fishing...so I had lots of my own personal background experience, just not as much formal education” indicating that formal education may give

educators more confidence or efficacy in a subject matter and more PCK. Each of the three educators interviewed attended the University of Missouri and received a degree in Agricultural Education.

Objective 2:

Describe the process of novel content implementation for Missouri high school agricultural educators.

The process of curriculum implementation, including an educator's sourcing, modification, and use of new content curriculum materials, based on the interviews, observations, and document analysis completed for this investigation, may be understood in terms of a flow chart (see Fig. 3.1), where multiple pathways lead to curriculum implementation. An educator must initially be motivated to pursue sourcing new materials or content. This may occur as a response to his or her beginning a career as an agriculture educator with confidence in only some of the material, or the educator's beginning to teach a class for which he or she has not taught before. Another source of motivation for curriculum material sourcing is the educator's realization that materials previously used are either outdated (as was suggested is the case for the state-wide IML curriculum materials), or lacking engaging, hands-on application in the classroom that the educator recognizes is most effective for student learning; students may struggle with textbook assignments, or show eagerness for activity. Whether interest in the use of computers in class assignments is founded in the teacher's or the student's support of this activity is unclear from these cases.

Once the educator recognizes a need for new materials, she or he may accept the inadequacy of the resources available and continue to use them based on a lack of time or perceived access to new materials, or she or he may proceed with the sourcing of content and curricula. The pursuit of content knowledge and materials appears to be largely simultaneous; while the educator is learning the material, she is also creating a curriculum, or vice versa. This is especially true when she is able to create a project-based curriculum wherein the students and the teacher are learning through experience, and “you’re learning as the kids are learning, you’re learning as you go...when you’re teaching it [with an experiential project]. You’re learning at a much more rapid pace, but you’re maybe a day ahead of the kids” (Teacher 2). Does the educator have a supportive budget for curriculum training and materials, and available time to invest in a 2-3 day training up to a 2-week training? If so, he may pursue a number of Summer Institute professional development programs or curriculum-specific University or corporate-sponsored curriculum trainings that require no more than 3 hours of travel time. During the school year, or when time and budget are otherwise sparse, internet searching and reaching out to networks of educators or agencies with curriculum materials is a go-to method for acquiring new materials and content. The educator will seek information that grows their content knowledge, while selecting from available resources whose applications are relevant to the unit standards, the CDE focus areas, and that may be enacted in the classroom with engaging, project-based, or hands-on lessons. Power point presentations are a common method of introducing a subject and when provided from an educator or online resource, as evidenced by class observations and online forums. These resources are also likely to be modified by the educator based on “the knowledge

that I think they're going to need" (Teacher 2). An educator may also choose to engage students with a visiting speaker from a nearby agency, as in Teacher 1's account of inviting Missouri Department of Conservation visitors; "they're really good about having agents that are available to come in and be a resource for the class".

Ultimately, in the phase of curriculum sourcing, educators will use what resources they know, whether they're most familiar with NAAE Communities of Practice, the use of online searches for credible materials, comfort in speaking with and acquiring materials from nearby agencies and businesses, or relying on state materials to build engaging lessons. Based on this pattern, ensuring that educators are familiar with diverse sources of information and curriculum content may be critical to the expansion of novel sustainable agriculture content. Growth of content knowledge in order to modify and use the materials in the classroom may also involve a curriculum training, when the educator and/or her school has the funding to support such activities. When funding from the school is not available, an educator may pursue corporate grant funds: "I think there's the one through DuPont that I tried that was basically going to be for the amount, and I also tried one of the Monsanto \$2500 grants that wouldn't pay for the whole thing but would get a lot closer. I haven't had any luck with any of the grants, but I'm still trying!" (Teacher 1).

Shorter duration trainings, 1-3 days, are more popular based on the availability of funds and time to dedicate toward lodging and travel expenses, although the shorter duration trainings also limit the amount of content or pedagogy an educator may absorb during that time. Teacher 3 pointed out, from his perspective as a father, "The ones [trainings] I go to are anywhere from one to three days... especially if they're further

away then you run into hotel time and if you have family, you're away from your family for that week of the summer, so it's not as appealing especially to older ag teachers who have families". For the longer duration trainings, "you go through an entire year's worth of curriculum in two weeks, so it's very busy, it's very fast paced. It can be very very frustrating... If I want to learn tree ID, I'm going to have to do that slow, I'm going to have to do that often, I'm going to have to do that repetitive" (Teacher 2). Some additional educator sourcing of content knowledge may be necessary for any duration of training, given the amount of information and PCK intended for transfer at these events.

Finally, the educator may further modify content gleaned from trainings, materials, or human resources in order to meet the needs and interests of their students and their own pedagogical knowledge and content interests. Use of materials in the classroom is most appealing when the educator is able to directly transfer content to an engaging, experiential lesson. "If I had to reiterate anything about this as you guys are developing this, it is really making it a 'here you go, you can now use this in a

Figure 3.1 *Missouri high school agriculture curriculum implementation considerations*

classroom', not 'here's all this awesome knowledge' because there's knowledge out there, I can read a textbook; I need the teaching method behind it so I can make it interesting to a student"

(Teacher 2). The educator's interest in a given subject area also determines the way it is applied in the classroom in addition to its further usefulness to students for CDE and state standard expectations. If the content is of great interest to the educator, more time will be spent on the topic given the depth of the educator's knowledge, "when you don't know it as well, you're obviously not going to be able to go into as much detail" (Teacher 3).

Teacher 2 also pointed out that "Honestly, if it is focused around a career development event, I'm going to find that helpful, and I think you're going to see people come to those [educator trainings]... just general agroforestry or general mechanics, an ag teacher says, oh I don't have time for that, I have to teach the contest".

A simplified model of the curriculum implementation process for a high school agricultural educator based on the above findings is represented as a flow chart (figure 3.1) of decisions based on educator prior knowledge, resource awareness, available funding and time, and motivation to provide engaging and relevant content to students.

CHAPTER 4. An Agroforestry Professional Development Program

Evaluation

Background and objectives

The introduction of novel content into high school course work requires careful planning for the effective growth of educator and student understanding. The act of teaching involves both pedagogical and content knowledge (Shulman, 1987; Cochran, 1991; Rice and Kitchel, 2015), which are simultaneously challenged with the introduction of a student-centered agroforestry curriculum developed for statewide use in the 2018 school year. Both the agroforestry teaching materials and professional development program were developed with consideration of what was learned in the first phase of this case study research. Based on the themes that emerged from interviews with teachers, observations of classes, and analysis of online curriculum forums, the following elements were considered essential to the design of the agroforestry program:

- 1) the cost and duration of the professional development program (PDP) should not limit any teacher from attending,
- 2) the teaching materials should include problem-solving,

project-based components to engage students and teachers as learners, and 3) the teaching materials should be easy to access and ready to use.

The agroforestry content included in the teaching materials constructed for this case study was selected in order to attain sufficient breadth and understanding of temperate agroforestry systems. Each of the five recognized temperate agroforestry practices are described and accompanied with student-centered learning activities and teaching strategies that mirror the formatting used by FFA and the Department of Elementary and Secondary Education in Missouri that is familiar to this group of agricultural educators. By including project- and problem-based approaches in the agroforestry curriculum and professional development program, it was expected that the content would be more digestible and more likely to be implemented. It is also critical that the educators who receive this training and set of materials are adequately prepared with the content knowledge and efficacy to serve their students. In an effort to best meet the needs of the educators who carry so great a responsibility, it is important not only to provide professional development programs that aim to increase educator pedagogical content knowledge, but also to continuously evaluate these programs in order to assess their effectiveness and improve upon them, including educators' perspectives in this adaptive process.

The agroforestry professional development program was scheduled as one of several "summer technical institutes" which are held each year throughout the month of June in locations across the state for agricultural educators in Missouri to advance their understanding in diverse subject areas. On May 1st, 2016 registration and summer institute topics for 2016 were sent to all Missouri agricultural educators from the MO

Professional Development Specialist at the University of Missouri Department of Agricultural Education. Within one week, registration for the Agroforestry Summer Institute was at capacity (15) based on space available at the hosting location, the Horticulture and Agroforestry Research Center (HARC) office. Two weeks prior to the training, an email was sent to each of the registered teachers with an agenda, directions, and a brief explanation of the voluntary research participation associated with this professional development program.

While collaborative professional development program (PDP) design with high school teachers was not feasible for the 2016 Agroforestry Summer Institute (ASI) due to the limitations of educator understanding of agroforestry at this time, the varied and voluntary context of summer institutes does give the educator choice and control in deciding to attend within the constraints of his or her schedule. The ASI was intentionally scheduled as a one-day training in order to provide maximum flexibility for those educators with families and busy summer schedules. Additionally, it was offered at minimal expense, so that financial constraints would be removed, and the small fee would serve primarily to engage commitment from the registered educators. Summer institutes are a recognized and widely communicated means for ongoing professional development among agricultural educators seeking greater understanding of any number of the many subject areas they are expected to teach. The ASI program offered diverse delivery methods, including collaborative project-based activities with a problem-solving, inquiry-based focus.

This evaluation of teacher understanding and efficacy outcomes from the 2016 pilot Agroforestry Summer Institute includes pre- and post-training survey-based

measures of the teachers' sense of preparedness to implement the teaching materials in their classes based on each teacher's self-report of the number of hours he or she plans to teach agroforestry content areas, the lesson components they feel most prepared and least prepared to teach, and the teachers' general understanding of agroforestry. Based on prior PDP effectiveness research, teacher age and level of experience is also included in the collected data for analysis of PDP outcome variability. With this PDP evaluation, questions may be addressed that inform future programs and curriculum design for high school agricultural educators, including *what impact on content knowledge can a short-duration PDP have on expected content enactment?* and *how do qualities of a teacher's experience and understanding play a role in his or her ability to enact PDP content?*

The objectives of this phase of the research were to:

- 1) *Describe the demographic make up, including career experience level, of agriculture teachers participating in a short-duration PDP for novel content implementation;*
- 2) *Describe the change in content understanding and planned content use from attendance of the PDP; and to*
- 3) *Identify elements of the PDP, the individual teachers, their level of experience, and their teacher-learning context that may have influenced the teacher's ability to learn and to implement PDP content.*

Research methods and procedures

On June 21st, 2016, 13 Missouri high school agricultural educators from 6 regions of the state participated in a one-day Agroforestry Summer Institute (ASI) professional development program at the Horticulture and Agroforestry Research Center (HARC) in New Franklin, MO from 10 am until 3:30pm to acquire the resources and skills necessary to teach a 2-module agroforestry unit in their high school courses. The ASI training focused on introducing the content and teaching strategies employed in the agroforestry curriculum by moving through the primary components of the modules, which are based on project-based and problem-solving approaches, followed by intermittent opportunities for feedback about how the activities may be modified for application in each teacher's class. A complete agenda of the day's activities are included in the appendix (C).

The 13 teachers who attended this professional development program agreed to participate in ongoing research regarding their experience employing the agroforestry materials presented at this event, and completed pre- and post-training questionnaires on the day of the event that described their motivations to attend, their plans for use of the content, and their growth in understanding of agroforestry.

Pre- and post-training paper surveys, reviewed for content and face validity by a panel of experts (n=3), were administered at the event. The survey was designed to maintain participant anonymity, with birth date used for pre- and post-survey matching. Other demographic information collected in the survey included years of teaching experience, and whether the school where they teach is in an urban, rural, or semi-urban county. The pre- and post-training surveys are included in the appendix (D, E). Pre- and post-training surveys also included a descriptive question asking attendees to "Define 'agroforestry' based on your current [pre]/ new [post] understanding of the topic" and a

quantitative question asking “How much time do you currently [pre] plan to / [post] spend on each of the following agroforestry subjects?” with a 0-4.5 scale based on the number of hours checked for each of 12 agroforestry subject areas. Since these two questions are repeated pre- and post-training, a descriptive and quantitative value for growth of understanding and efficacy respectively may be drawn from these respondent answers, while acknowledging the limits of these measures given the additional variables that may impact these responses (e.g. anxiety taking surveys, various restrictions to the amount of time allotted to the agroforestry content in class).

Additionally, the pre-training survey includes a descriptive question regarding the teacher’s informal, formal, or non-formal prior agroforestry training or education, in order to assess whether this has any impact on the teacher’s content knowledge growth or efficacy. The pre-training survey also includes a question regarding motivation to attend the training, with a strongly influenced, somewhat influenced, and did not influence scale (1-3), rating general interest in agroforestry, desire for greater pedagogical content knowledge in agroforestry, desire to meet student need for understanding of sustainable practices, desire to fulfill state curriculum standards or CDE test preparation, interest in updated material that includes conservation approaches in agriculture, and affordability and/or accessibility of the training. The words “sustainable” and “conservation” were used separately in these questions in an effort to mitigate the impact that any perceptions of these sometimes-controversial and/or ambiguous words may have had on a teacher’s response.

The post-training survey includes overall program evaluation questions, asking teachers to rate the quality and quantity of content, the time for discussion and practice,

the usefulness of materials, accessibility and affordability of the training, in addition to descriptive questions asking teachers to identify the curriculum activities that they feel most prepared to teach now and least prepared to teach now, with a follow-up question asking what the teacher needs (e.g. further training/ access to resources) to feel well-equipped to teach the lessons. The post-training survey follows the agroforestry class content question (mirrored from the pre-survey) with a question regarding how the teacher anticipates using the curriculum materials (rated as definitely will use/ may use/ not likely to use) in classroom lessons, to inform the Supervised Ag. Experience Program, to enhance FFA content and to advise student career paths, in your own farming practices, or other. The final post-survey question is related to prior curriculum material modification motives research, with check boxes for (topics previously identified in a qualitative research project) interest in new materials based on providing more up-to-date information to students, including more hands-on activities and project-based lessons, overlapping with teacher interests, making use of textbooks and other formatted materials, or to best suit teacher's methods for greater use of technology, for greater peer-to-peer learning (group problem-solving), or for maximized use of school materials.

As the primary instructor of the ASI training, my own voice as the researcher is also included in the analysis of the program as a reflective description of my experience. As the training advances from its pilot stage to an annual program, the teachers who participated in the initial training will be part of a collaborative effort to understand the outcomes (curriculum potential, teacher self-efficacy and understanding) of the PDP. This research is thus “grounded on a participatory world-view bringing together action and reflection, theory and practice, in participation with others to pursue practical

solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and communities” (Morales, 2016).

Data analysis protocol

The data collected for this evaluation is both qualitative and quantitative, using both descriptive survey question responses and Likert-scale numerical responses. The pre- and post-training survey responses were compiled in an Excel spreadsheet whereby the quantitative response figures were summed for each age and experience level, and the relative importance of survey content variables was determined as a percentage of positive responses. The relationship between responses and teacher demographics, efficacy, and understanding outcomes was estimated using graphic representations of patterns between these factors.

Descriptive responses were coded using key words denoting meaning related to 1) level of understanding of agroforestry, 2) level of prior experience in agroforestry, and 3) quality of preparedness to teach various components of the agroforestry curriculum. Reflective notes following the ASI are also used as a descriptive frame of reference from the point of view of the primary instructor.

Findings

Objective 3:

Describe the demographic make up, including career experience level, of agriculture teachers participating in a short-duration PDP for novel content implementation.

The Agroforestry Summer Institute was held at a central location in the state, at the University of Missouri's Horticulture and Agroforestry Research Center in New Franklin, Missouri, 40 miles west of Columbia. Given this central location, educators from all 6 areas of the state were able to attend the training. In figure 4.1, locations of teacher's home schools are indicated with a yellow star. Educators traveled between 40 minutes and 5 hours in personal vehicles to attend the one-day program. Breakfast and lunch was provided during the program, and a \$15 registration fee was required to attend. First year teachers were allowed to attend for free.

Of the 13 teachers who attended, 61.5% were in their first five years of teaching high

school agriculture. Of these early career teachers, three had 5 years of experience, three had 3 years of experience, and two had one year of experience. One teacher had between 6 and 11 years of experience, two teachers had between 12 and 20 years of experience, and one teacher had 28 years of

Figure 4.1 Locations of teachers who attended 2016 agroforestry training in New Franklin, MO

Figure 4.2 Age and career experience of participating teachers

Table 4.3 A comparison of statewide and ASI participant (sample) agriculture teacher experience

2014-15 FT Missouri Ag Teacher Experience Summary			% of total (sample)
Teachers	Years Experience	Percent of Total	
158	5 years or less	32.8%	61.50%
105	6 - 10 years	21.8%	2.30%
148	11 - 20 years	30.8%	7.60%
56	21 - 30 years	11.6%	7.60%
14	more than 30 years	2.9%	0%

experience (figure 4.2). Their ages ranged from 25 years to 59 years. Relative to the state averages for the 2014-15 school year, it is apparent that a larger percentage of early career teachers attended the training than are present in the school system (figure 4.3). While this population does not represent the demographic of Missouri high school agricultural educators at large, this difference was not surprising given that early career teachers are more likely to seek novel content, as indicated by the first phase of this case study. Additionally, the presence of some teachers who are in the middle or late in their careers is also indicative of the dynamic nature of agriculture course work, and the need that teachers recognize for updated material.

Urban, semi-urban, and rural school communities were represented in this group, with eight educators located in rural communities, three located in semi-urban communities, and one located in an urban community.

Objective 4:

Describe the change in content understanding and planned content use from attendance of the PDP.

A pre- and post-training survey comparison revealed substantial gains in teacher understanding of agroforestry content and planned classroom hours. Before the training, 75% of the participating teachers reported no prior agroforestry training or experience (formal, informal, or non-formal). Those that did report having prior experience or training in agroforestry cited examples focused on general forestry rather than agroforestry, as in “assisting with the forestry CDE contest in college”, attending forestry summer institutes, and the presence of sawmills in the teacher’s home town. Similarly, initial definitions of agroforestry often confused the subject with forestry, or simply defined agroforestry as a general combination of forestry and agriculture, which while not completely inaccurate, indicates a very simplified understanding of the topic. An example of this language is highlighted in the response “Agroforestry is a sustainable forestry method”, with an honest addendum that “I do not know much about this practice”.

Post-training survey agroforestry definitions indicated a much greater depth of understanding among participants. Key words provided in the introductory segment of the training (from the definition provided using 4 “I”s as a chunking tool for

conceptualizing content: the **I**ntentional **I**ntegration of trees/shrubs with **I**ntensive management of **I**nteractions with crops/livestock) were used in nearly half of the teachers' responses, that agroforestry is intentional, integrated, intensive, and interactions-based; although one of these five respondents retained the forestry focus without a connection to agricultural applications. Five of the post-training survey definitions of agroforestry were detailed, accurate, and written in the teacher's own words, which is a positive indication that comprehension of the basic ideas central to agroforestry (including conservation/ ecosystem services, marketable products, intensive management, and integrating agriculture with the use of trees/shrubs) was achieved by at least 42% of the teachers. All other definitions included at least two of these basic ideas, compared to the initial survey that showed much more disconnection of ideas; 33% of the teachers' initial definitions indicated no prior understanding of the topic. The level of understanding of agroforestry measured by this qualitative pre- and post-training comparison was not associated with age or experience level.

Teacher self-efficacy for content enactment, measured by the difference in the number of hours each teacher stated that he or she planned to teach agroforestry topics, and the content or materials he or she felt more and less prepared to teach, also showed significant growth. The agroforestry topics for which all attending teachers taught the most before the training were timber stand improvement (TSI): 17 hours, wildlife benefits of agroforestry: 10 hours, marketing agroforestry products, and windbreaks: 9 hours (figure 4.4). The total number of hours taught for every other agroforestry topic including riparian forest buffers, silvopasture, forest farming, biomass production, economics and financial tools were each less than 5 hours among the entire group. Those

with at least 5 years of teaching experience were more likely to teach a diversity of subjects that cover topics related to agroforestry in some capacity.

Figure 4.4 *Expected growth in classroom hours for agroforestry topics: pre, post, and change*

Prior to the ASI training, the group of teachers as a whole spent a total of 64 hours teaching agroforestry-related topics. Following the training, this sum agroforestry class time increased to 220 hours. The largest increases in stated hours of agroforestry teaching time were seen among those with less than 5 years of experience. By topic, TSI still ranked high (22 hours total), although riparian forest buffers received the most dedicated time (23 hours), followed by wildlife benefits of agroforestry (21.5 hours), creating an agroforestry plan, silvopasture (20 hours each), windbreaks, alley cropping, and marketing agroforestry products (19 hours each). Two of the topics listed for the measure of class content time, keyline design and agroforestry for biomass production, were not explicitly described in the training, although 75% of teachers still planned to teach these topics following the training, granted the number of hours denoted to these topics were the lowest (11 and 13 total hours, respectively), followed by agroforestry economic and financial tools and forest farming (16 and 16.5 total hours, respectively).

Objective 5:

Identify elements of the PDP, the individual teachers, their level of experience, and their teacher-learning context that may have influenced the teacher's ability to learn and to implement PDP content.

As can be seen in figure 4.5, those with more years of teaching experience exhibited a smaller gap in the difference of number of agroforestry teaching hours before and after the training. The difference in efficacy growth between more and less experienced teachers as evidenced by the difference in the number of hours of classroom time planned for agroforestry may indicate that less experienced teachers are more open to new content, that these teachers have the support needed to build self-efficacy during their early years of teaching, and/or that more experienced teachers are less willing to change and perhaps more realistic in terms of classroom time allotment. From this research, the sample size is too small and the measure of efficacy too broad to draw any of these conclusions; however, these themes are explored in more depth in the third phase

of the case study.

Figure 4.5 *Change in novel content classroom hours with teacher experience*

The second measure of content efficacy is derived from responses to the questions “Which of the curriculum activities do you feel most prepared to teach now?”, “Which of the curriculum activities do you feel least prepared to teach now?” and “What do you need (e.g. further training/ access to resources) to feel well-equipped to teach these lessons?” Teachers who completed the training and post-training survey were most likely to feel prepared to teach the activities that describe the 5 recognized agroforestry practices, and preferred group and hands-on activities and games that were included in the lesson plans. One teacher said he/she was prepared to teach the complete lesson plans and activities, while others mentioned only the topics within agroforestry (e.g. “alley cropping, silvopasture, riparian”) that he/she felt most comfortable teaching now. The agroforestry planning and design assessment, “activities to help retain knowledge,” and “group activities” were described as components of the content that teachers felt most prepared to use; these fall in the category of project- and problem-based activities.

This tendency to feel most comfortable and to prefer project-based activities is mirrored in their responses to the post-training survey questions regarding motivation to modify curriculum materials, in which “inclusion of more hands-on activities and project-based lessons” was checked by 100% of the teachers. Modification of curriculum materials was also driven by interest in greater use of technology (Power Points, student computers), greater peer-to-peer learning (group problem-solving), and “providing more up-to-date information to my students” (84% of teachers responded positively to each). Many of the teachers in this cohort (75%) were also interested in “tailoring the curriculum to agriculture practices in my region”. The teacher responses to these questions support the findings observed in the first phase of the case study.

The set of questions regarding “Motivation to attend the Agroforestry Summer Institute” also indicated importance of “updated material that includes conservation approaches to agriculture”, for which 84% of teachers were “strongly influenced” and the other 16% were “somewhat influenced” to attend the training. Meeting student need for understanding of sustainable practices followed updated material as most influential in teachers’ motivation to attend. Half of these teachers also ranked the motivation to “fulfill state curriculum standards or CDE test preparation” as strongly influenced; only one teacher marked that this did not influence his/her motivation to attend. Teachers rated a number of factors on a scale of importance, with 3 as the highest ranking of importance in their motivation to attend the training (figure 4.6).

Figure 4.6 Average rating of factors related to Motivation to Attend

The curriculum activities teachers described as “least prepared to teach now” were relatively diverse, which may indicate heterogeneity of teacher pedagogical knowledge. Three teachers with diverse levels of experience noted ill preparedness to use the concept map assessment tool, although one noted, “I loved the concept map. Kids do well with these and administrators love them”. This teacher was among the least experienced teaching, although his/her age may be related to more recent exposure to this kind of innovative assessment tool. Another teacher described her inability to be “able to go [into] more in depth on some practices due to some lack of knowledge, but it will come with time”. This statement was also found in responses indicating a need for more basic knowledge of types of trees, shrubs, and grasses, and a need for “help with identification of trees and shrubs”. While these are critical areas relevant to agroforestry (and forestry) content knowledge, a one-day PDP may not be sufficient to meet these needs in addition to growth of agroforestry-specific understanding. Interestingly, most of the teachers who attended, when asked in what class they planned to teach this material, responded that they would use this to supplement their wildlife conservation and forestry class, rather than the agriculture science II class for which it is intended to be used as a component of the statewide curriculum (for 2017 pilot release). Based on their minimal

prior understanding of agroforestry, it is not surprising that some may have come with expectations outside of the bounds of the topic.

In order to directly evaluate the program itself, we asked “To what extent were your expectations for this training met?” to prompt participant reflection of the quality of information, quantity of information, time for discussion and practice, usefulness of materials, and accessibility and affordability of the training. Quality, usefulness, and access/affordability were all ranked “entirely” met by 92% of respondents. Quantity of information and time for discussion and practice were rated “entirely” met by 58% of teachers and “somewhat” met by 42% of teachers. Based on this measure of program satisfaction, time for discussion could be emphasized in the future, in addition to providing a larger pool of resources and curriculum. However, extending the duration of the program to accommodate this additional quantity of content and discussion time may reduce accessibility of the program for some educators.

A more detailed evaluation of the PDP in terms of teacher needs is visible in the descriptive teacher responses to questions regarding teacher preparation. A general theme of these needs is for greater background knowledge of agroforestry, trees, and examples. The limited time allotted to a one-day PDP restricts the quantity of content that can be provided to educators during the training, although materials and extended resources may be sent to registered teachers in advance of the training in order for those who have less content knowledge at the onset to feel prepared to expand their content knowledge and pedagogical knowledge at the Agroforestry Summer Institutes. While growth of agroforestry understanding was apparent, several participants’ focus on forestry in their definitions of agroforestry suggests that attention should be given to

explaining how these subject areas differ and how they overlap.

One teacher's request for a "list of contacts for certain areas when questions arise" will be addressed more comprehensively as agroforestry-trained individuals enter the communities of practice that will be established in the Savanna Institute's Perennial Map; however, it is our hope that these educators also feel comfortable reaching out to the University of Missouri Center for Agroforestry for assistance. Assessing the means to strengthen this connection may be beneficial for long-term agroforestry curriculum implementation success. Another teacher identified a need for "a full curriculum, especially tailored to Forestry CDE", which is beyond the scope or goals of this training; however, a more clear description of the training in advance of teacher registration may help alleviate these unmet expectations. Given that the statewide FFA-DESE forestry curriculum is also being updated in the coming year, some need for background knowledge of trees and forestry may also be addressed outside of the context of an agroforestry PDP.

It is also clear from the teacher's descriptive responses that more time should be allotted to explaining and practicing using concept maps for agroforestry assessment. During the 2016 ASI training, teachers were given a brief explanation of concept maps and how to begin them, and were instructed to construct a concept map during the course of the day, with intermittent reminders to continue adding and reorganizing their maps. At the end of the day, teachers had a chance to grade each other's concept maps and see how diverse they can be while including great depth of understanding. While some teachers were already familiar with this tool, by providing examples of completed concept maps that include the information expected for this unit, teachers may have an

opportunity to become more versed in this creative assessment method.

Upon reflection of the pilot ASI training, as the primary instructor, I noticed the need for more clear organization of the physical curriculum materials, including tabs and page numbers in the binders for a smoother introduction of the entirety of the content and to direct attention to various components of the printed lesson plans during the course of the day, during which time we perform a sample of the primary activities and assessments. Teachers' preparation to use the group and hands-on activities practiced during the PDP, despite that a fully accurate and detailed understanding of agroforestry was not unanimously attained, also points to the potential value of providing information more intentionally in sequence with the activities practiced and in advance of the PDP, so that a conceptual framework grows both through learner-centered/ teacher-centered problem-solving activities, and also by helping the teachers feel supported with contacts and resources to help build their knowledge and confidence over time (Diaz-Maggioli, 2004). Helping teachers achieve a level of pedagogical content knowledge for agroforestry that enables teacher self-efficacy begins at the Agroforestry Summer Institute, but must also continue after the teacher returns to his or her classroom. Providing a network of knowledgeable agroforestry-specialists and easily accessible resources will be critical for a continuous and enduring impact on agroforestry curriculum implementation and teacher self-efficacy.

CHAPTER 5. Content Enactment and Teacher Self-Efficacy

The cohort of 13 teachers who voluntarily registered for and attended the 2016 Agroforestry Summer Institute left the one-day program with a marked increase in content knowledge gain, teaching materials ready for use, and plans to enact the content, as was documented in pre- and post-training surveys (figure 4.4). A follow-up with this group of educators after one school year was intended to describe actual content enactment, and further explore the relationship between teacher experience, teacher self-efficacy, and the final component of novel content implementation: enactment. Given the narrow frame of this purposive sample, this research is intended only to explore the relationship between teacher self-efficacy, career experience and novel content implementation for the teachers participating and cannot be extended to a wider population. However, by identifying self-efficacy inputs and content implementation results in the context of career experience and teacher-learning context, this exploration may inform future studies of agricultural educator teacher self-efficacy and PDP planning. The number of teachers recruited for an interview following survey response will be based on the expectation to reach a saturation point of variation in responses (Creswell, 2014).

Questions guiding this research component are *what is the relationship between teacher self-efficacy and novel content implementation for high school agricultural educators?* with sub-questions including *how does a teacher's level of career experience play a role in his or her sources and degree of teacher self-efficacy?*, and *how do sources of teacher self-efficacy change over the course of a teacher's career?* From these research questions, and emergent themes from teacher interviews following survey completion, a greater depth of understanding regarding Missouri's high school agricultural educator pedagogical and content knowledge efficacy may be applied to the continued improvement of novel content implementation in this realm.

The objectives of this phase of the case study are to:

- 1) *Describe the variation in agriculture teacher self-efficacy among the participating teachers;*
- 2) *Describe the variation in agroforestry content enactment achieved in the first school year following the teachers' attendance of the short-duration PDP*
- 3) *Evaluate the relationship between teacher self-efficacy, career experience, and agroforestry content enactment in this sample; and to*
- 4) *Identify specific sources of teacher self-efficacy that may have had a significant influence on the teachers' ability to implement PDP content.*

Research methods and procedures

Data was collected through an online survey administered via Qualtrics and individual semi-structured interviews (recorded and transcribed) following analysis of the survey results. Using an online instrument, participating teachers were able to access and

complete the survey expediently and anonymously without the need to mail materials, given the varied locations of individuals in the sample. One week after initial distribution of the Qualtrics link, a follow-up reminder to complete the survey was sent, and a phone call reminder was utilized to maximize the response rate. Additionally, teachers who completed the questionnaire received an Amazon.com gift card as compensation for their participation (funded by the Student Teaching As Research STAR Award in the School of Natural Resources at the University of Missouri).

The survey instrument (see Appendix F) was adapted from the Wolf et al. (2010) modified Teachers' Sense of Efficacy Scale (TSES) (Tschannen-Moran & Woolfolk Hoy, 2001) designed specifically for agricultural educators. The TSES instrument includes 8 items for each component of educator efficacy. Included in this survey are questions regarding the following components: 1) instructional strategies, 2) classroom management, and 3) student engagement, with sections identified from Wolf et al.'s (2010) agricultural educator TSES: 1) classroom management, 2) SAE, and 3) content standards. The first section of the Qualtrics survey used in this study employed Wolf et al.'s (2010) self-efficacy scale for agriculture teachers, with matrix style questions asking teachers to rate their own level of capability to, for example, "motivate students to learn" and "implement an agriscience curriculum in a coherent sequence". The second section asked teachers to describe their use of the agroforestry content and materials from the PDP (mirrored from pre- and post-PDP surveys) with questions such as "In what contexts did you use content from the Agroforestry Summer Institute (June 2016) this school year? Check all that apply: I used the Agroforestry Summer Institute content... In new classroom lessons/ In adapted classroom lessons (modified from previously planned

lessons)/ To inform SAE projects/ To advise student career paths/ In my own farming practice/ Other/ None of the above”. The third section asked for demographic information including gender, age, and years of teaching experience.

The follow-up interviews (see full interview question guide in Appendix G) were purposively selected based on survey responses that fall in the outlier range of data. This sample is of particular interest because these teachers may yield significant predictors, significant results relating variables, or insignificant results (Creswell, 2014).

Wolf et al.’s (2010) adaptation of the TSES (Tschannen-Moran & Woolfolk Hoy, 2001) instrument achieved content validity and face validity with a review from a panel of experts. A pilot and post-hoc test confirmed reliability with Cronbach’s alpha above .85 for each domain of the instrument. The additions of demographic and content implementation components of the survey were assessed for content and face validity by a panel of experts advising the project (N=3).

Data analysis protocol and coding structure

The purposive sample of teachers who attended the 1-day agroforestry PDP were sent an electronic message describing the research and a request to participate in the online Qualtrics survey describing their efficacy and PDP content use in the last year. The survey was available for three months over the summer of 2017, with two reminder messages sent and two follow-up calls to teachers to ensure maximum response rate. The survey was designed to be completed at the convenience of the teacher, and he or she was encouraged to participate during a time and in a place where they could focus on the survey without distractions. Likewise, recorded interviews took place over the phone,

and were transcribed and coded without identifiers in order to retain participant confidentiality.

A p-value approach was used to identify the strength of the relationship between teacher self-efficacy and curriculum implementation from the quantitative questionnaire data. This type of correlation was the preferred method for identifying the strength of the relationship between teacher self-efficacy and curriculum implementation because of the scale of the purposive sample (not probabilistic) and the time-and-place specific nature of the case study (Oliver & Hinkle, 1982). While this does not inform patterns in the agricultural educator population as a whole, it is intended to describe this specific case as a tool for understanding possible relationships that may exist in the curriculum implementation context. At least three interviews with those representing outliers in the initial data set are expected to fulfill qualitative data saturation. Teachers were asked to confirm consent at the onset of the questionnaire and at the onset of an interview.

The transcribed interview materials were coded using the same methods described in chapter 3, first using an open coding process, followed by axial coding to organize codes into categories and themes. Immediately after each over-the-phone or in-person interview, reflexive interviewer notes were recorded for concepts that may have been stressed or unexpectedly omitted. Following transcription, a coding process involved reading and re-reading interview transcripts for pattern matching and identification of emergent themes. The organization of codes from this set of interviews is presented here as an outline of categories identified under each subset of topics addressed in this research. Under each set of codes is a reduced category indicated with a “>” identified during the process of axial coding (Creswell, 2013).

(1) Sources of teacher self-efficacy

- TSE as measure of student success
- Greater time spent with students, Long-term engagement
- Student relationships as a measure of classroom management ability
- Challenging students and hands-on activities
- > Student engagement as primary content and pedagogy TSE feedback
 - Preservice teacher enthusiasm and expertise
 - Classroom management experience
 - Reflective teacher solidarity
- > Classroom TSE from physiological arousal and shared experience

(2) Pedagogical content knowledge growth

- Preservice teacher and mentor observations
- Professional development and teacher or administrator groups
- Collaborative and evaluative feedback
- Reflective practices and teacher solidarity
- Online Communities of Practice
- > Teacher learning communities
 - Test-prep (CDEs and college-credit exams)
 - Engaging students with novel content and activities
 - Extent of subject areas expected
- > Student preparedness and long-term success
 - Humility and learning

> Limits of high TSE on PCK growth

(3) Agroforestry as novel content case

Familiar layout

Student interest variability

Flexibility of placement of content

Shift to online materials

> Opportunities for agroforestry in the classroom

Need for more basic understanding

Time and support for growing comfort with content

> Barriers to agroforestry in the classroom

Using these codes, categories, and reflective memos, themes were identified based on the relative frequency of each code and the degree to which it was stressed in the interview, document, or observation. Verification of the emerging themes was confirmed with the educators interviewed and observed for this project.

Findings

Objective 6:

Describe the variation in agriculture teacher self-efficacy among the participating teachers.

Teacher self-efficacy, measured using the adapted Wolf et al. (2010) scale for agricultural educators, was self-rated by eight of the teachers who participated in the

agroforestry professional development program on a scale of 0.00 – 9.00. At least 9 sub-questions for each construct (classroom, content, and SAE efficacy) were averaged to determine each teacher's score. For this group of educators, TSE scores ranged from 6.96 to 8.00 for classroom efficacy, 5.89 to 9 for content efficacy, and 6.92 to 9 for SAE (Supervised Agricultural Experience) efficacy (figure 5.1). Table 5.1 illustrates each area of efficacy, expected and actual content hours enacted in order of years of teaching experience.

Table 5.1 Experience, efficacy, and content enactment of 8 agricultural educators

years experience	classroom efficacy	content efficacy	SAE efficacy	pre-ASI hours	post-ASI hours	actual hours enacted
2	7.35	5.89	7.31	0	14	9
5	7.26	7.11	7.46	5	34	24
7	7.48	6.67	7.92	10	15	13
18	7.35	7.22	7.85	6	16	11
20	8	9	9	2	7	6
22	6.96	7.56	7	12	16	8
22	7.09	6.89	6.92	10	17	13
29	7.17	6.78	7.38	6	11	16

Objective 7:

Describe the variation in agroforestry content enactment achieved in the first school year following the teachers' attendance of the short-duration PDP.

As is depicted in table 5.1, the total hours of agroforestry content enacted by each teacher ranges from 6 hours to 24 hours. The median number of agroforestry content hours enacted is 12 hours, and the mean number of hours enacted is 12.5 hours. Pre- and post-professional development program hours of agroforestry classroom content can be compared to actual hours enacted in order to gain a sense of the accuracy of the teacher's predictions of expected content hours following the training. The expected range in

content hours (as was self-reported by each teacher immediately following the PDP) was 7 to 34 hours. The median number of hours expected immediately after the PDP was 16.5, and the mean number of hours expected is 16.4. The difference in expected and actual content enactment outcomes suggests that either the teacher's were more excited to use the materials immediately after the content was presented, that they did not have the support they needed to enact the content during the year after some time had passed since the PDP, or that the realities of planning and implementing novel content are more challenging or limiting than each teacher would have expected at the time of the PDP.

Table 5.1 also shows the number of hours actually enacted compared to the number of hours expected by each teacher to be included as reported by each teacher immediately following the PDP. A graphic display of the number of expected classroom agroforestry hours compared with actual enacted hours can be seen in figure 5.6. In this figure, teachers are listed on the x-axis in the same order as table 5.1, where teacher 1 is the least experienced, and teacher 8 is the most experienced. Largely, teachers enacted slightly less content hours than expected immediately following the PDP, except for the most experienced teacher, who was able to enact slightly more hours of agroforestry content than expected. As will be discussed in the next section, there may be many reasons why these patterns exist.

Figure 5.2 *Expected and actual content hours enacted*

Objective 8:

Evaluate the relationship between teacher self-efficacy, career experience, and agroforestry content enactment in this sample.

A correlation of each teacher self-efficacy construct (content, classroom, and SAE) with total enacted hours of agroforestry content (actual), and years of experience was performed using SPSS (table 5.3). Based on the outputs of this correlation, there is no significant relationship between total enacted content hours and any of the three TSE constructs or years of experience. Research that has been done on TSE in the past would indicate that a relationship between TSE and content enactment outcomes would be likely (Shulman, 1987; Cochran, 1991; Gess-Newsome, 1999); however, the small size of this sample population may obfuscate this relationship if indeed it exists for Missouri high

school agricultural educators at varying levels of career experience. A more extensive study of the agricultural educator population would be necessary to examine this relationship in more depth.

Table 5.3 *Correlations between teacher self-efficacy (TSE) constructs, enacted content hours, and experience*

		Correlations				
		Classroom TSE	Content TSE	SAE TSE	Total Enacted Hours	Years of Experience
Classroom TSE	Pearson Correlation	1	.565	.963**	-.386	-.179
	Sig. (2-tailed)		.145	.000	.345	.672
	N	8	8	8	8	8
Content TSE	Pearson Correlation	.565	1	.681	-.236	.427
	Sig. (2-tailed)	.145		.063	.574	.291
	N	8	8	8	8	8
SAE TSE	Pearson Correlation	.963**	.681	1	-.301	-.036
	Sig. (2-tailed)	.000	.063		.469	.932
	N	8	8	8	8	8
Total Enacted Hours	Pearson Correlation	-.386	-.236	-.301	1	-.234
	Sig. (2-tailed)	.345	.574	.469		.577
	N	8	8	8	8	8
Years of Experience	Pearson Correlation	-.179	.427	-.036	-.234	1
	Sig. (2-tailed)	.672	.291	.932	.577	
	N	8	8	8	8	8

** . Correlation is significant at the 0.01 level (2-tailed).

What is visible from this correlation analysis is the relationship between each teacher self-efficacy construct. If a teacher has a high TSE score for classroom management, he or she is also likely to have a high score for the SAE (significant correlation $p=.000$). In this group, the relationship between TSE for classroom management and SAE was less strong with content efficacy ($p=.063$). This difference may indicate the conceptual and practical distance between these sub-groups within the construct, where SAE and classroom TSE are more associated with pedagogical knowledge, and content TSE with content knowledge. Likewise, while not significant, the relationship between years of teaching experience and content TSE is the strongest

among the sub-groups of teacher self-efficacy. By this measure, with more years of teaching experience, a teacher may be more likely to have a higher content TSE score. Whether this makes a more experienced teacher with higher content TSE more or less likely to implement novel sustainable agriculture content is a question explored in greater depth in the final objective of this analysis.

Objective 9:

Identify specific sources of teacher self-efficacy that may have had a significant influence on the teachers' ability to implement PDP content.

Interviews addressing the teacher's experiences, sources of feedback, challenges and successes with regard to self-efficacy and content enactment (see appendix G for interview protocol) were conducted with 4 of the teachers who attended the 2016 ASI and 1 teacher whose class was observed in the initial inquiry. The teachers interviewed represent a wide range of ages, experience levels, and backgrounds. In order to ensure the anonymity of the teachers who participated in this part of the research, they are identified as follows. "Teacher A" is a 59 year-old female who has been teaching for 30 years in a rural county; "Teacher B" is a 25 year-old male who has been teaching for 4 years in a rural county; "Teacher C" is a 28 year-old female who has been teaching for 6 years in an urban county; "Teacher D" is a 50 year-old male who has been teaching for 29 years in a rural county; and "Teacher E", who did not participate in the agroforestry PDP but whose perspective is valuable for its diversity, is a 58 year-old male who has been teaching for 4 years in an urban county.

The interviews revealed a number of themes, some of which were expected based on previous literature on these topics, while others represent emergent concepts that may further inform the way teachers grow their pedagogical and content knowledge. These concepts are organized and presented based on the following areas of research inquiry related to content enactment: (1) sources of teacher self-efficacy at varying levels of career experience, and (2) agroforestry curriculum implementation opportunities and barriers.

Sources of teacher self-efficacy at varying levels of career experience

One of the strongest and most consistent emergent themes regarding sources of teacher self-efficacy was the role of student success and engagement. While it is understood that a teacher's sense of efficacy impacts their students' ability to succeed, it is less documented how that student success simultaneously enters the feedback loop of increasing a teacher's self-efficacy in return. Tschannen-Moran, Woolfolk Hoy and Hoy's (1998) model of the feedback of sources of efficacy information (figure 2.1) identifies the primary efficacy inputs as outlined by Bandura (1977), but the specific aspects of a teacher's experience that contribute to these inputs is less understood.

Mastery experiences are thought to be the most influential of these inputs (Bandura, 1977; Knobloch, 2001). For all of the teachers interviewed, their perception of their mastery of ability was primarily a factor of their students' success and engagement in their classes. Teacher B stated plainly, "Interacting with the students and seeing their level of success at the state and national level is a big influence for me". This teacher was referring specifically to the students' performance at Career Development Events

and with FFA. For Teacher C, a positive relationship with her students was an indicator of her classroom management ability. When asked how she has learned to master this skill, she responded that in part it's a matter of "developing relationships with students. I can see that now that I've been teaching for a few years. You get those kids back that you've had". In effect, they felt they had mastered an experience when their students responded positively. Teacher D exemplified an alternative view that suggests a lower classroom TSE. From his perspective, "It just depends on the group of kids that come into the classroom. Attitudes: you can't do anything about that, and I struggle with that still. There are kids they don't prepare you for in college; that's something only experience can show you."

This student feedback can also engage a teacher in reflective assessment of his or her teaching, as long as the teacher is empowered with the TSE to recognize this opportunity. Teacher B explained that "When I give an exam, if I have students that really bomb that test, that always makes me go back and look at what *I* could've done better". Likewise, for all of the teachers interviewed, the level of engagement they sought from their students was also motivation for them to include more hands-on and experiential lesson components. Teacher C explains, "It's for the students; I always try to break the class up somehow with activities". Several teachers also described that agriculture is often where students who do better with hands-on activities than, say "with English" (Teacher C) may end up. In addressing this circumstance with "IP students" (these students have an "Individual Plan" and assisting aids), Teacher A shared that "we do shop projects...sometimes they're able to do those sorts of things, and you feel more successful when they've completed something hands-on or a project; you realize they've

accomplished something”. As a measure of TSE, Teacher B also recognized that “maintaining the attention of students is probably the most important thing. So varying up your teaching styles and including not just lecture, but also having a lot of hands-on activities in and outside of the classroom” helped him to feel competent as a teacher.

This student feedback of efficacy may also be considered a type of vicarious experience, where teachers may feel a sense of physiological arousal (as a self-efficacy input) when their students perform well at a state or national contest. While the vicarious effect of student success does seem to build as teachers gain more classroom experience, this input source of teacher self-efficacy often begins during preservice and early career teaching. When Teacher C observed her mentor teachers before she started teaching, she expressed that “The enthusiasm of the teachers was a big motivator for me; seeing their enjoyment for their job and the way they motivated students to learn...by creating relationships with them in class”. These teacher observations persist for many early career teachers who are encouraged to observe their peers in their first years of teaching

Teacher A and Teacher D, who did their preservice teaching 30 years ago, added a historical perspective about pre-service agricultural educator training. “Thirty years ago women weren’t ag teachers, so we were breaking a little bit of a trail at that point in time. Some schools didn’t allow us to come because we were female. But the teachers who did, I think they were more open-minded... and now we have a majority of teachers who are female” (Teacher A). “Twenty-nine years ago we had zero support, unless you looked to neighboring ag teachers. You were just thrown in a classroom to get after it” (Teacher D). These teachers were able to see that, as Teacher D explains “I think we’re doing so much better with student teachers now. It leads to teacher retention, just keeping

teachers in schools.” They also recognized their early classroom experience as the most valuable learning tool for growing their TSE when other sources were lacking, in addition to the support they had from more experienced teachers at their school.

Later in a teacher’s career, as Teacher A describes, “in my position you’re typically working with a younger teacher who has different teaching styles. They’re a lot more tech savvy than I am”. At all times throughout a teacher’s career, he or she may have opportunities to observe other teachers, depending on the established professional development expectations set by the school. Since each teacher has her own pedagogical content knowledge, agriculture teachers may uniquely find opportunities to grow their PCK through a community of teacher-learners no matter their level of experience.

Teacher D, also a more experienced teacher, mirrored Teacher A’s sentiment when he described his experience working with a student teacher who has now been teaching for 6 years, and “I look at what he’s teaching and what he’s doing now, and man he’s blowing me out of the water with the stuff he’s doing”. Teacher D attributed this difference to the way an agriculture teacher’s education has changed, where today colleges are innovative in their methods for preparing teachers with the pedagogical knowledge to feel competent enough in the classroom to learn the extensive content needed for this subject.

These collaborative teacher and administrator professional development communities vary in structure and composition at each school, and sometimes change each year as teachers and principals find value in shifting methods. The home school for Teacher C had the most extensive of these professional development communities; she is part of a “leadership committee” that includes both teachers and administrators.

Following peer observations, she described, “we come back with our shared teacher

planning groups and hash those observations out. That was refreshing. You see that other teachers are struggling with the same things you are... Otherwise in teaching you're pretty much on your own". Teacher C explained that while she did gain a few meaningful teaching methods from these observations and reflective meetings, what she found more impactful from these opportunities was a sense of solidarity with other teachers. By sharing challenging experiences and tools each teacher had learned to address these challenges, growth of pedagogical knowledge and "verbal persuasion" efficacy inputs (Bandura, 1977) may increase a teacher's overall classroom TSE.

Teacher D expressed that this collaborative solidarity has grown as younger teachers have demonstrated greater connectedness among a network of educators. Even though Teacher D is the sole agriculture teacher at his school, he is still part of a supportive group of teachers. This teacher shared a story about a young teacher who was struggling in her classes, with content and classroom management. "She called some ag teachers, and we just got together and drove there, showed up one day and had a kind of intervention. All ag teachers have that network if they ask for it. Now it's 15 years down the road and she's still teaching. I would've never guessed that when I saw some of the crap she was in."

Teacher E, who became a teacher after retiring from his career as an engineer, had also not felt prepared with classroom management skills when he became an agriculture teacher in his 40's. While he had developed his content knowledge in agriculture (especially agriculture mechanics and welding, which he teaches specifically among the agriculture teachers in his school district) over the years, he had not developed pedagogical knowledge. He found that professional development for agriculture teachers

that focused on content was “mostly useless” to him. However, during Career Development Events, which take place over a full day outside of school, “you get 30 teachers in one room waiting for 4 hours. That’s when I learn, that’s where I get ideas for activities and teaching methods” (Teacher E). The collaborative nature of peer-to-peer learning opportunities is one area that may be further developed for the growth of novel content efficacy at agroforestry professional development programs.

What appears to be a somewhat less effective source of efficacy from administrative and professional development efforts in schools (yet is more consistent at each school) is intermittent observations and feedback from superiors. While Cochran (1991) recognized the potential value of feedback from administrators as efficacy input, this may be limited to the positive feedback a teacher receives. More often, the teachers interviewed found that classroom observations may also prove to be somewhat frustrating and critical (perhaps diminishing TSE). “Some of the things you’re doing, they tell you ‘Yes, you’re on the right track and doing what you should be’, and other times they’ll say ‘you did this’ and it’s like ‘yeah, I know I need to improve in this area’, but I was just focused on something else that day” (Teacher C). This feedback is seen more as an evaluative tool, rather than a collaborative tool, and as such may serve more to identify areas for PCK growth rather than to increase TSE. Teacher B explained that in his school, “He [the principal] is always in the classrooms here and providing teachers with feedback through email, especially if he sees something he doesn’t like”. While this may serve as an important way to ensure responsible teaching practices, it may not always serve to increase a teacher’s TSE. According to Teacher D, “a lot of principals are worn out coaches on a power trip”. “He decides to walk through for 5 or 10 minutes and we’re

doing something that's not on the lesson plan; you know things change, assemblies and such. It kind of helps me think 'I need to be on task for my plan for the day'" (Teacher A). A consideration of how negative feedback may also be used as a tool for increasing teacher self-efficacy (perhaps with follow-up observations that indicate growth) could improve the way these evaluative aspects of professional development are implemented.

A necessary distinction between teacher self-efficacy and teacher confidence is the responsibility a teacher holds, when he or she has a high level of efficacy, for both positive and negative student outcomes. In measuring TSE, it may not be clear whether a teacher has a high level of confidence (perhaps false confidence) in their abilities, or a high level of TSE, due to the nature of these scales. However, the inclusion of a qualitative approach in this measure enables some reflection on this difference. Teacher B, who is in his fourth year of teaching, exemplified this distinction. He is a teacher with a high TSE rating according to the survey scale, and expressed control over his classroom outcomes, yet perceived his teaching as being satisfactory to the point of needing no further improvement. Thus, it may be worthwhile to consider the limits of TSE on a teacher's willingness to grow, and the effectiveness of ongoing professional development.

Agroforestry curriculum implementation opportunities and barriers

Each teacher interviewed was also asked about his or her use of the agroforestry teaching materials, what worked well or didn't, and how professional development for this kind of content could be improved. Certain elements of the teaching materials and professional development were identified as more or less effective for each teacher, and

components of the teacher's classroom and learning context also emerged as important considerations for future agroforestry and other sustainable agriculture curriculum implementation efforts. These themes were relevant to both content and pedagogical aspects of the novel content implementation process.

Just as students played an important role in a teacher's sense of his or her classroom and content efficacy, the student-teacher relationships that develop as a result of the increased time spent on agriculture projects presents both opportunities and barriers for agroforestry as novel content. The lasting relationships that these teachers have with their students may enable more long-term student engagement with the content. As Teacher E explains, "I still keep in touch with my ag teacher from when I was in high school; he's been a big influence on me". Teacher B reported that "I check in with my students after graduation to see how they're doing as far as the college setting and helping them prepare". If a student's interest is piqued by agroforestry, their teachers may help see them through to a career where they can apply agroforestry concepts.

Including more hands-on activities was also echoed by each teacher in this set of interviews, as it was in the first phase of this inquiry into curriculum implementation for high school agriculture. Teacher D explained "anything that's a hands-on activity where you can get the kids directly involved right away is what I look for; and with forestry that's sometimes kind of hard. They removed my forest here at the school so they could build a lagoon... Our classes are 50 minutes long, so I don't have time to take kids out there [Knob Noster State Park] during class." Since students respond well to hands-on activities, teachers are motivated to include more of this material in their classes. The demonstration of agroforestry practices may provide ways for teachers to bring more

hands-on forestry material into their classes as well. Already, there have been teachers who have committed to planting more trees with their students, and to cultivating mushroom logs as a result of the agroforestry professional development program. These experiences may further be carried to student SAE projects as agroforestry content becomes more familiar.

There are several ways that the agroforestry teaching materials may become more widely used, beyond the small groups of teachers who learn the content in professional development programs each summer. Teacher A emphasized, “things are changing. They’ve just started this online agribusiness course, so I’m teaching that using more technology. All the lessons are on smart boards; the kids don’t really have a textbook, you print things off. Online is the way things are going to go, and that’s what students are getting used to”. For the older teachers interviewed, this may be a challenge, but for the younger teachers, this could be a way to increase the accessibility of the agroforestry content. Teacher C explained that, like many other young teachers, she uses the National Association of Agricultural Educators Communities of Practice forums (and Google searches) to find new material. By making this content available at these sites, and by making it more web-friendly (in addition to hands-on components) the network of teachers who are trained to teach agroforestry in Missouri may help diffuse this material throughout the country.

Familiarity of the layout of the teaching materials was also described as a benefit to its usability. “The lesson plans were laid out, you have your objectives listed. That’s a huge one that administrators are looking for, and you have your strategies and content just like what we know how to read. I thought that was helpful” (Teacher C). While this

may have aided the teachers in understanding how to use the content, it is also clear from this case that the extent of content agriculture teachers are expected to teach often limits their ability to integrate novel content. Each teacher interviewed was teaching at least 6 unique classes in the school year. For teachers in school districts with multiple agriculture teachers, this may be more manageable, as was the case for Teacher E. But this is the exception more than the rule. The breadth of this content knowledge is exemplified by Teacher A's comment "I teach aquaculture, I teach a wildlife conservation class, I teach a vet science class, plus just the traditional ag 1, ag 2, livestock and crops", and Teacher C's explanation of her content challenges "welding or shop class can be a challenge for me because I'm more of a natural resources-animal-plant-business-leadership type person".

The agroforestry content was largely seen as something that could be used in segments for multiple courses. Teacher D described this as "drop in" content. "I don't have the ability to just throw in a whole unit, so a lot of that was what I call 'drop in'; I can drop it in here and there." Other teachers felt that this was potentially advantageous as it afforded flexibility for use of the materials whether they were teaching wildlife conservation or crop science. As students' interests vary, the content could also be used to meet these needs. Teacher A explained that she hadn't used as much of the materials as she expected in 2016, but "it's a different group of students this year, and I feel it will match their interests better than it did my group last year." Teacher C also expressed usefulness from this flexibility when she said "This year I don't have wildlife, but I have a plant science class, so I'll use it there this year."

Still, the agroforestry teaching materials are only as useful as the teachers see value in the content. “We do a lot here with the alley cropping and obviously talk a lot about windbreaks and erosion control. Those are the two biggest things I’ve pulled from it aside from using the information to help guide me as far as how I create the lesson” (Teacher B). Used in pieces, the teachers may be able to pull what they find relevant to their existing classes, but the concept of agroforestry (as a systems-based approach) may be neglected. What Teacher D identified as the most important factor in teacher use of materials, is still missing for agroforestry as a single whole concept: “All the ag teachers are really interested in the curriculum, but you know nothing motivates a teacher more than a contest”...“You want it taught, put it in a contest, it’ll get taught.” In Missouri, there are 25 Career Development Event contests where FFA students compete at the regional, state, and national levels. Teachers and area experts sit on committees to update the content that is included in these contests each year. As contest requirements change, teachers are likely to shift their class content to prepare students for the year’s contests. The forestry contest includes some test questions on riparian forest buffers and windbreaks, but is otherwise lacking content on agroforestry practices.

Confusion about the difference between agroforestry and forestry persists. The need for a very basic understanding of trees and other woody perennial crops will need to precede any in depth training on agroforestry. By including more specifics about agroforestry practices as distinct within the forestry CDE contests, teachers may find more value in understanding the material. Teacher D revealed that there have been new efforts to connect teachers with contest developers this year. “For the big changes in the contest, we started doing conference calls where ag teachers that are interested in this

contest can call in and listen to the discussion. That gives professors a chance to explain the reason why certain things change.” This also allows teachers interested in a given subject area to connect as they help each other develop their content knowledge and classroom activities for these updated contest requirements.

Overall, any of the methods used to increase implementation of an agroforestry curriculum will require time and support. “Any subject you teach for the second time around, you get a little more of what you’re saying because of the students before” (Teacher C). When teacher support systems are in place, via conference calls and teacher networks, and the content is accessible through familiar teaching material sources, teachers may enter a growth period of becoming familiar with the content, with the ways their students respond to the material, and beginning to support other teachers in their use of hands-on and engaging methods to enact novel content.

CHAPTER 6. Conclusions and Discussion

Insights at each stage of curriculum implementation

Over the course of this case study, each stage of a novel content implementation process was explored in depth in order both to improve the effectiveness of agroforestry (and other sustainable agriculture) curriculum implementation practices, and also to identify themes important to this process that require further investigation. By commencing this analysis with a small sample of educators using a segment of a curriculum that includes multiple areas of novel content, the patterns and lessons observed in this process may be extended to advance teachers' ability to bring up-to-date and engaging sustainable agriculture content into the agriculture science curriculum as a whole. The following conclusions address the most critical elements of this case study that may have a role in agriculture science curriculum implementation efforts, as called for by Ball & Cohen (1996), McKim & Velez (2016) and others.

Curriculum development

In each phase of this case study, agriculture science teachers expressed the need for keeping classroom content up-to-date and engaging for students, while balancing this effort with the limited time and resources a teacher may have at their disposal. As a result, online networks of agriculture teachers, such as the National Association of Agricultural Educators' (NAAE) Communities of Practice forums, serve as easily accessible sources of materials. Early career teachers were the primary users of these

online networks. Throughout a teacher's career, nearby agriculture teachers and agriculture professionals, whether in her school district or regionally, also provide support and ideas for continuous improvement of teaching strategies and content. These teacher communities are likely to act unseen in what Borko (2004) outline in the professional development and teacher-learning context, and if effectively employed, can have a profound effect on curriculum potential (Ben-Peretz, 1975).

When novel sustainable agriculture content is developed outside of existing teacher networks for updated curriculum, an opportunity exists to enter these established teacher-learning communities in order to expedite the transfer of pedagogical content knowledge. In Missouri, the use of standard teaching material formats and the inclusion of hands-on activities that address the need for student engagement can also make novel content more accessible for teachers at all career experience levels. Agriculture teachers and students are embedded in a classroom context that emphasizes hands-on skills that give both teachers and students a sense of accomplishment. Based on what was learned from this sample, this experience-based learning should be a primary component of any updated curriculum materials for agriculture science (Preszler, 2009; Johnson et al., 2015). As classroom technology advances with Smart boards and class-wide internet access, teaching strategies that make use of these resources are also more likely to fit into the existing classroom context. When possible, the co-creation of a relevant curriculum in partnership with teachers is ideal in order to address both the classroom and teacher-learning contexts (Borko, 2004; Garet et al., 2001; Ball & Cohen, 1996; Van Den Akker, 1988).

High school agriculture teachers are also highly motivated to help their students excel in the Career Development Events (CDE), often referred to as “contests”. These events are subject-specific assessments of individuals and teams of students who compete at a regional, state, and national level. When a teacher’s students advance in these contests, they are likely to feel equally validated for their preparation of the students. As a result, the majority of the teachers who participated in this study (50% strongly influenced, 42% somewhat influenced) were motivated to learn novel content in order to prepare students for Career Development Events. Likewise, if novel content is adequately represented in CDE assessments, teachers are likely to be more interested in including this material (Cronin-Jones, 2006). The continuous updating of CDE content will require greater collaboration between sustainable agriculture researchers and innovators and those who sit on the CDE contest committees. While this has the capacity to hinder more broad opportunities for learning about regionally appropriate agroforestry practices, ensuring that general agroforestry content has greater representation on the forestry and agriculture science CDE tests may also encourage greater depth of understanding for novel and up-to-date content integration.

Prior to the 2017 Agroforestry Summer Institute, the agroforestry teaching materials were expanded based on what was learned in 2016. The 2017 content included more extensive resources and professional networks that are intended to help support educators who are eager to include up-to-date information on conservation in agriculture in their classes. Explicit lab components were also added in the updated agroforestry curriculum, including both hands-on field labs for agroforestry applications, and computer-based labs that meet teachers’ interest in greater use of technology. These

lesson plans were made available to the teachers who participated in 2016 and 2017 agroforestry professional development programs, and will be posted on the NAAE online forum and on the University of Missouri Center for Agroforestry website to maximize ease of access.

Professional development program design

Professional development programs serve as intensive opportunities to disseminate pedagogical content knowledge. Resource availability is also relevant to this aspect of teacher-learning, where 2-3 day trainings were viewed as an appropriate duration to avoid limiting teacher attendance or information overload, despite that longer-duration programs have been shown in other cases to be most effective for teacher-learning (Supovitz & Turner, 2000; Desimone, 2009). Shorter-duration programs were found to be effective in this case when they addressed content that could be directly used in the classroom, essentially focusing on pedagogical content knowledge, instead of content knowledge alone. Hands-on and peer-to-peer learning was also seen to be essential for maximized PCK transfer in professional development, as has been recognized by Diaz-Maggioli (2004). The use of these experiential teaching methods in PDPs supports the feedback loop of teacher self-efficacy inputs, where vicarious experience and mastery of experience, the most powerful of efficacy inputs (Knobloch, 2001; McKim & Velez, 2016), can be achieved in advance of classroom content enactment.

During the 2017 ASI, the components identified as most influential in 2016 were strengthened. The training was better tailored to teachers' interests, needs, prior

experiences, and understanding of agroforestry and related topics based on the results of this research. By providing agroforestry content resources in advance of the training, teachers had an opportunity to begin the PDP with a basic understanding of the content, and thus more clear expectations. A forestry PDP component was also included in the 2017 ASI, which helped to connect prior content knowledge and also to delineate the concepts specific to forestry and agroforestry. Using an updated version of the 2016 ASI pre- and post-training surveys, definitions of agroforestry (as a measure of content knowledge growth) provided by the teachers at the 2017 ASI demonstrated a more accurate understanding of agroforestry as a unique entity in agriculture than the 2016 cohort.

The 2017 training also included greater use of hands-on activities and peer-to-peer learning. Teachers were encouraged to participate in a mushroom log inoculation activity that they could repeat as a small-scale classroom project demonstrating one aspect of forest farming. Teachers once again had an opportunity to teach one of the five agroforestry practices to their peers in the group as a practice run for the classroom. Additionally, the event was hosted at a site where two of the high school agriculture teachers who participated in the PDP had recently installed a food forest and windbreak with their students. By giving these teachers an opportunity to share their experience and enthusiasm working with trees in their classes, other teachers were able to relate to the challenges and opportunities they may encounter in their own classes should they pursue hands-on agroforestry field experiences. The success of these improvements to the agroforestry PDP supports the effectiveness of the teacher-centered goals outlined by

Diaz-Maggioli (2004), and the effectiveness of classroom experience on growth of pedagogical content knowledge and TSE (Rice & Kitchel, 2015; Cochran, 1991).

Evaluation of the 2017 ASI program was improved by increasing Likert-scale degrees for greater values of variance and more precise measures of significance. In the future, hosting a collaborative forum with educators and other stakeholders during the planning process may also provide a more comprehensive view of what teacher learning and classroom context changes require accommodation of materials and approaches in the PDP. By repeating the evaluation process each year, a larger sample of teachers who participate in the PDP will also grow our understanding of how the program can be modified for most effective PCK growth.

Content enactment

The content enactment findings from this case study elaborate on other research that has described factors influencing curriculum implementation. A teacher's beliefs about how students learn (Cronin-Jones, 2006; Cusick, 1983) was one of the strongest factors among this group of educators. Specifically, teachers shared that what is most likely to be engaging for their students, including hands-on and project-based lessons, is the content that connects students to real-world applications of their interests. When students are engaged and learning, teachers are more likely to continue to include the material. Since agroforestry involves trees and other woody perennial plants, the space to apply agroforestry cultivation practices may be limited at high schools. Even the limited presence of mature trees was a barrier for one teacher's ability to implement hands-on activities for forestry and agroforestry. By assisting teachers with the sourcing of funds

and supplies for agroforestry-related class projects, the Center for Agroforestry and other sustainable agriculture groups may be able to ameliorate this barrier.

Since most teachers had not been exposed to the concept of agroforestry beyond piecemeal practices (windbreaks and riparian forest buffers), the influence of teachers' beliefs and judgments about the subject matter (Cronin-Jones, 2006; Gess-Newsome, 1999) was minimal in this case. However, content that was known to be included in a Career Development Event test was more likely to be enacted. Currently, riparian forest buffers and windbreaks are included in a single forestry CDE test question. While these may be appropriately situated in the forestry exam, other agroforestry practices, such as alley cropping and silvopasture would be more suited to an agronomy or livestock CDE, respectively. Given the interdisciplinary nature of agroforestry, the teachers who enacted it in the first year following the 2016 ASI found themselves using parts of the teaching materials in wildlife conservation classes, and other parts in crop science classes. As Marshall and Herring (1991) and Agbaje et al. (2001) noted about sustainable agriculture content implementation in general, the integration of agroforestry content into existing subject areas may be more likely than the implementation of an entirely new and complete unit on agroforestry. This flexibility of content use may be beneficial for teachers to enact the content in parts over time, but it also may keep agroforestry from being recognized as a complete content area worthy of significant class time.

In either case, regional networks of teachers were observed to have a strong influence on the dissemination of pedagogical content knowledge. While teacher self-efficacy was not related to content implementation among this group of educators (also observed in a larger sample by Poole & Okefor, 1989), the strength of teacher networks

emerged as a more prominent factor in follow-up interviews with these teachers. The support systems for agroforestry content are expected to grow as more teachers complete the professional development program each year. These support systems can manifest in varied forms. Recommended options for ongoing support and development include participatory programs using learning communities to provide mentoring and peer coaching opportunities, reflective collaborative action research, and peer observation (Fenton, 2016; Diaz-Maggioli, 2004). Fenton (2016) suggests that teacher peer observation throughout the school year serves to grow a more trusting and collaborative teaching and learning community as an alternative to “dump and run” professional development programs. The teachers in this study reported gaining more pedagogical knowledge than content knowledge from peer, mentor, and preservice teacher observations, but the community of educators that grows from these reflective opportunities may also allow for content knowledge exchange.

As educators become familiar with the agroforestry content, collaborators at the University of Missouri Center for Agroforestry are encouraging these educators to join a mapped community of practice on the Savanna Institute’s “Perennial Map” where agroforestry farmers, producers, supporters, researchers, and educators may join an action-oriented conversation about making agroforestry more accessible and digestible. The Savanna Institute, a non-profit organization based in the Midwest that facilitates research, education, and outreach for widespread agroforestry applications, developed the Perennial Map as a networking tool for mutual support between sustainable agriculture stakeholders. This networking opportunity may not only connect teachers to other teachers, but also support relationships between teachers and nearby perennial crop

farmers who can demonstrate agroforestry practices when school resources are limited, allowing for the practice, discussion, and feedback recommended by Covay Minor et al. (2016) to build teachers' content knowledge in meaningful ways.

Longer-duration professional development for high school agriculture teachers who are motivated to include agroforestry in their curriculum may also become more accessible through the University of Missouri Center for Agroforestry's Agroforestry Academy, hosted in the center of the state. With the assistance of scholarships, this program could enable high school teachers to be regional experts in agroforestry that serve as point persons within their teaching communities. Further contact with the natural resource professionals who have completed this program can likewise assist teachers in their content knowledge development.

Future research: extending the case

In 2016, the Center for Agroforestry was awarded a Professional Development Program grant from USDA SARE (Sustainable Agriculture Research and Education) that supports the continued training of high school agricultural educators to deliver agroforestry content. As a result, an ongoing evaluation of the novel content implementation process is possible. By investigating other aspects of the teacher-learning and classroom contexts, findings from this inquiry may be further clarified. While the teacher's perspective was a focus of this research, student perspectives and long-term outcomes are of interest to determine the impact of teacher training, and to identify discrepancies between intended and actual learning outcomes. The concept of

curriculum potential (Ben-Peretz, 1975) can then extend beyond the classroom to the impact a curriculum might have on farming practices in the state. If teachers' understanding of the novel content is adequate, student understanding should reflect this in a cascade of awareness (D'Souza et al., 1993) from the classroom to real-world applications.

The extension of this case can also allow for a closer look at the effect of time on implementation. Poole and Okefor (1989) identified that a time line of 3 to 5 years is not unreasonable for full implementation of an educational change. Teachers in this study also estimated that with more practice using the materials in class and gauging student response, the content would become more familiar, and they would be more likely to feel comfortable including more of the content.

The impact of ongoing agroforestry professional development and content implementation may also be affected by teacher attrition rates. An area worthy of further study, the impact of teacher support networks built in to professional development may have a profound effect on the retention of early career teachers who are more likely to leave the profession when job stress is high and alternative opportunities are available (Lemons et al., 2015; Myers et al., 2005). As novel sustainable agriculture content is integrated into the agriculture science curriculum, improved mechanisms for pedagogical content knowledge development could counteract teacher attrition. Likewise, if teacher attrition remains high, the number of trained educators that leave the profession may diminish the long-term awareness effect (D'Souza et al., 1993). In the 2016 cohort of 13 agroforestry-trained educators, two are no longer listed (no longer teaching in Missouri), and two moved to different school districts. Following teachers and their students as

their understanding of agroforestry leads to long-term applications thus presents a logistical challenge.

As the high school agriculture science curriculum advances toward the inclusion of sustainable agriculture practices in all content areas, the findings from this study may be further tested through practice. The importance of hands-on, problem-solving, and project-based pedagogies for both teacher and student learning have been consistently demonstrated (Barron & Darling-Hammond, 2008; Preszler, 2009). Curriculum and professional development design for agricultural educators should reflect this finding. Innovation in teacher-learning networks can also enhance the value of peer-to-peer support for curriculum implementation, as was observed in this case and others (Poole & Okefor, 1989; Diaz-Maggioli, 2004; Cochran, 1991; Garet et al., 2001). Sources of teacher motivation to seek novel content, including the desire to prepare students for standardized tests and to fill content knowledge gaps with engaging material, reflects the agriculture teacher's interest in progressing with up-to-date content that will prepare their students for agricultural careers. The advancement of these components of curriculum implementation for high school agriculture may situate agroforestry as an example for future sustainable agriculture content integration goals.

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APPENDICES

A. Novel Content Implementation: Teacher semi-structured interview questions

Prior to the pre-PDP curriculum modification inquiry interviews, I will know the following information:

How many years the teacher has been teaching high school agriculture

His/her gender and age

His/her location (rural/ urban, student demographics)

Introduction: I'm here to talk with you about your use of curriculum materials, where you source them, how you might modify them, and what experiences you've had with curriculum teacher training opportunities.

Verification of consent and opt out at any time. Interview will last no more than 2 hours (probably more like 30 minutes), recording.

1. First, tell me about your background in agriculture and as an educator;
 - a. What would you say you know most about of the agriculture content you teach; what do you know least about?
 - b. Do those unique skills impact what or how you teach? If so, how?
1. Describe for me your process of developing agriculture class lessons.
 - a. To what extent do you use the FFA or DESE provided curriculum?
 - b. Where else have you gathered curriculum resources?
 - i. Have you found any particularly useful resource that has been especially helpful for planning your lessons?
 - c. Have you encountered DESE ag curriculum materials on topics that you were previously unfamiliar with?
 - i. How have you gone about becoming familiar with this new material enough to implement it in the classroom?
2. Are you likely to modify those sourced curriculum materials?
 - a. If so, how, and for what purpose/ with what motivation?
3. Have you assisted in any way with FFA/DESE curriculum development?
 - a. Tell me about your interaction with that process.
 - b. Do you feel that teachers' and students' needs are being met with provided curriculum?
4. Have you attended any teacher conferences or trainings for using new curriculum materials?
 - a. What did you find most helpful at those trainings?
 - b. What could have been better at those trainings?

5. Given a curriculum pertaining to a subject that is entirely foreign to you, how likely would you be to attend training for the curriculum and use the curriculum in class?
6. As you may know from the initial invitation to participate in this study, one of the goals of this study is to be able to develop an agroforestry curriculum and training for use in the Agriculture Science II class.
 - a. Have you heard of agroforestry?
 - b. Would you be interested in participating in a follow-up piloting of the agroforestry materials, given a 1- or 2-day summer training?

Based on institutional review board protocol, participating teachers were sent a written consent form, and vocally consented at the time of the interview, including that they are participating in research, the purpose of the research (without stating the central question), the procedures of the research, the risk and benefits of the research, the voluntary nature of research participation, the subject's right to stop the research at any time, and the procedures used to protect confidentiality. Interviews were audio recorded on an mp3 recorder and subsequently transcribed. Participant identifiers were removed from all documents and replaced with codes "T1" for teacher 1, "T2" for teacher 2, etc. Semi-structured interviews took place where the teacher was comfortable and able to take breaks if s/he wished.

B. Novel Content Implementation: Sample Class Observation Notes

Wildlife, Conservation, Forestry class observation
4/7/16 Thursday 8:55am - 10:20am

Notes

Class delivery: Experiential?
 computer-based?
 labs?
 resources available (limiting)?
 CIDE-based lessons?
 source of materials?

student engagement
 teacher interaction
 hands-on activities
 problem-solving
 teacher/student displays of enjoyment/boredom

white board

teacher desk

cabinets counter

Door

teacher computer station

• this is the first week back after spring break

• a 1st yr teacher

shop, welding room

garage door to outside

9.00am: review tree ID discussion

(T) teacher draws branching patterns IIII

?s to students IIII IIII IIII IIII

w/ stu. responses IIII

hand motions (3 students) ♂♂♀

~ half students responding consistently ~ half quiet

quick 'call + response' review

9.05 review terms from power point w/ images - lights off

2 stus discuss a? about 'heart wood' mid review

1 stu each was assigned a term, reviewed for class

*teach. elaborates / reads definition from slide

↑ "sorry, it was a bad question"

- term review evolves into T reading from slide relating to a familiar S experience (back row boys chatting quietly)
- 9:15 "when we were outside Tuesday" ... measuring trees w/ Biltmore stick
"grab a laptop in the back..."
you can use your phone/ipad - read diversity article
- 9:17 laptops open, NOBLE foundation (from google search)
[I give a 5 min introduction to AF, my background]
multiple bulletin walls covered in FFA Winner ^{Nat'l} ^{that} ^{plagues}
"Sponsored by... Hsgvarna, John Deere
Kubota, STIHL, Bridgestone tires, Smithfield,
Anyota LifeScience N.Am"
- 9:35 article review
the most engaged kid, most interest is asked to
T (desperately) "what else did you get... anything?"
10 plants native to MO that tolerate shade
5 shrubs, 5 perennial forbs or grasses
height, growth pattern, wild life it attracts
- 9:42 → w laptop computer search, take notes to share
(on screens: google search
MDC website
MO Native plants pdf)
- 9:45 - S asks about a shade level for beauty berry
T: "Yeah, maybe on the W side"
back row ♂ chats about Special K cereal w another ♂
T: "Quite a few sedges too"
S: "I can't find any" ... S2 "Are these native?"
students mostly google searching plant species (once identified)
or wildlife → plants
- written on white board: "Objective: wildlife
explore MO's native trees, 115 + differentiate between species"
on wall drawings + collage of wildlife, food webs

- 10:02 T checks in "Do you have 10 species?" 1 ♂ raises hand
On computers, students all working diligently, on task
- 10:06 T "lets talk about ones we found"
calls on students - S responds too quietly for others to hear
♂ in front yawns, stretches.
3 students engaged in discussion why ^{native} grasses preferred by ♂.
T: "Say it 3 times fast!" "s: "Spice bush swallow tail"... S smiling
- 10:13 students start packing up, putting away computers.
T: think about the management component
- 10:15 students leave

Review

Technology use/Resources

Pedagogy

- 9:05-9:17 powerpoint — teacher-led Q+A review
- 9:17-10:02 Individual laptops — student pairs - written assignment
→ maximum student participation
- 10:02-10:13 whiteboard notes — assessment minimal participation
- 10:13-10:15 reflection

Reflection

- Students have regular engagement with laptop/ipad/^{smart} phone technology, and used it responsibly in this class
- Teacher expressed doubt in her ability/performance - at of self-consciousness in being observed? First-year teacher
- Powerpoint slides were effective visual aid, but did not stimulate student participation in the lesson.
- Small group work enabled one-on-one teacher interaction ^{student}

C. Professional Development Program: Agroforestry Summer Institute Agenda

The Center for Agroforestry
University of Missouri

A Global Center for Agroforestry, Entrepreneurship and the Environment

Agroforestry Summer Institute

Tuesday, June 21st, 2016 10am – 3:30pm

At the University of Missouri Horticulture and Agroforestry Research Center
(HARC)
10 Research Center Rd
New Franklin, MO 65274
(660)848-2268

9:30am – 10:00am Welcome educators

Park at main office, check in at front desk

Coffee and snacks provided in the office conference room

10am – 10:45am Introductions, Formative Assessment

Dr. Michael Gold, UMCA Associate Director

Dr. Hank Stelzer, Forestry Extension

Hannah Hemmelgarn, UMCA Graduate Research Assistant

Overview of agroforestry unit curriculum, additional resources

Concept map assessment tool introduction

Your role in agroforestry education research

Pre-training survey

5 minute Break + Concept map building

10:50am – 12:15pm What is Agroforestry? Objectives, Approaches

Why agroforestry, why now? (Dr. Gold) – 10 minutes

Unit objectives

Interest Approaches

Working Trees pair-share introductions

Woody perennial plant bio card activities

“Red Rover” Runoff simulation

12:15pm – 12:45pm Lunch (provided)

12:45pm – 2:15pm Agroforestry Practices Overview “Conference”
What do agroforesters do? (Dr. Stelzer) – 10 minutes
Become an agroforester: Conference presentations activity
Return to Agroforestry Concept Maps
Questions and feedback

5 minute Break

2:20pm – 3:00pm Agroforestry Planning and Design
Design considerations (Dr. Gold) - 10 minutes
Small group agroforestry designs with “case study farms” worksheets

3:00pm – 3:30pm Wrap Up and Reflection
Post-training survey and follow up
Debriefing activity, extended resources and helpful contacts

*A tour of HARC agroforestry research areas will be available following the training.

D. Professional Development Program: Pre-training survey

The Center for Agroforestry
University of Missouri

A Global Center for Agroforestry, Entrepreneurship and the Environment

Agroforestry Summer Institute

June 21st, 2016

Horticulture and Agroforestry Research Center, New Franklin, MO

Dear participant,

The University of Missouri Center for Agroforestry is gathering information about today's workshop in order to improve future professional development programs, and for research aiming to better understand educators' use of agroforestry curriculum materials. To assist in this effort, we invite you to complete two short surveys today: one prior to the start of the workshop, and one at the end of the day. Each survey will take approximately 5-10 minutes to complete.

Upon completing today's Summer Institute on agroforestry, you will be equipped with a 6-module agroforestry curriculum, including student assessments and an educator feedback request. After completing your use of the unit in class, we ask that you send student assessment documents (concept maps and agroforestry design worksheets, in addition to any assessments you create) to the University of Missouri Center for Agroforestry via email, fax, or physical mail by the end of April 2017. A short phone conversation regarding your use of the unit materials and extended agroforestry resources will follow in order to assist in our collection of educator feedback.

Your responses will be recorded anonymously to protect your identity to the extent provided by law. You do not have to answer any questions that you do not wish to answer, and you may stop answering questions at any time. There are no risks to participating. Benefits to participating include improved Agroforestry Summer Institutes, and agroforestry curriculum modifications that best meet your needs. There is no compensation for participation.

If you have any questions about this survey, please contact:

Dr. Michael Gold

Associate Director, University of Missouri Center for Agroforestry

203 ABNR Bldg

Columbia, MO 65211

goldm@missouri.edu

Your thoughts and opinions are very important to us. Thank you!

Pre-Agroforestry Summer Institute Survey

10:00am – 3:30pm June 21st, 2016

Horticulture and Agroforestry Research Center farm New Franklin, MO

Survey ID

Your birthdate __/__/__ (mm)/ __/__/__ (dd) __/__/__ (year)

[This information will only be used to match pre- and post- surveys]

1. Motivation to attend the Agroforestry Summer Institute

<i>To what extent did the following influence your attending the training?</i>	Strongly influenced	Somewhat influenced	Did not influence
General interest in agroforestry	☐	☐	☐
Desire for greater pedagogical content knowledge in agroforestry	☐	☐	☐
To meet student need for understanding of sustainable practices	☐	☐	☐
To fulfill state curriculum standards or CDE test preparation	☐	☐	☐
Interest in updated material that includes conservation approaches in agriculture	☐	☐	☐
Affordability and/or accessibility of the training	☐	☐	☐
Other _____	☐	☐	☐

2. Define “agroforestry” based on your current understanding of the topic.

3. Do you have prior formal, informal, or nonformal education in agroforestry?
Please list your **prior agroforestry training** including the type (formal, informal, or nonformal), the relevant agroforestry subject areas, and the year completed.

4. Agroforestry class content

<i>How much time do you currently spend on each of the following agroforestry subjects?</i>	None	<1 hr	1-3 hrs	>3 hrs	SAEP
Creating an agroforestry plan	☐	☐	☐	☐	☐
Alley cropping	☐	☐	☐	☐	☐
Forest farming	☐	☐	☐	☐	☐
Silvopasture practices	☐	☐	☐	☐	☐
Windbreaks	☐	☐	☐	☐	☐
Keyline design	☐	☐	☐	☐	☐
Wildlife benefits of agroforestry	☐	☐	☐	☐	☐
Riparian and upland forest buffers	☐	☐	☐	☐	☐
Agroforestry and biomass production	☐	☐	☐	☐	☐
Marketing agroforestry products	☐	☐	☐	☐	☐
Agroforestry economics and	☐	☐	☐	☐	☐

financial tools					
Timber stand improvement	☐	☐	☐	☐	☐

5. Please tell us a little about yourself:

I teach in a

- ☐ Rural county
- ☐ Semi-urban county
- ☐ Urban county

I've been teaching agriculture/ forestry for _____ years.

Thank you!

Your thoughtful responses will help us improve upon
agroforestry curriculum and trainings.

E. Professional Development Program: Post-training survey

The Center for Agroforestry
University of Missouri

A Global Center for Agroforestry, Entrepreneurship and the Environment

Post-Agroforestry Summer Institute Survey

10:00am – 3:30pm June 21st, 2016

Horticulture and Agroforestry Research Center, New Franklin, MO

Survey ID

Your birthdate __ __ (mm)/ __ __ / (dd) __ __ __ __ / (year)

[This information will only be used to match pre- and post- surveys]

1. Program evaluation

<i>To what extent were your expectations for this training met?</i>	Entirely	Somewhat	Not at all
Quality of content	☐	☐	☐
Quantity of content	☐	☐	☐
Time for discussion and practice	☐	☐	☐
Usefulness of materials	☐	☐	☐
Accessibility and affordability of training	☐	☐	☐

Which of the curriculum activities do you feel most prepared to teach now?

Which of the curriculum activities do you feel least prepared to teach now?

What do you need (e.g. further training/ access to resources) to feel well-equipped to teach these lessons?

2. Define “agroforestry” based on your **new understanding** of the topic.

3. Agroforestry class content

<i>How much class time do you plan to teach the following subjects having now completed the agroforestry training?</i>	None	<1 hr	1-3 hrs	>3 hrs	SAEP
Creating an agroforestry plan	☐	☐	☐	☐	☐
Alley cropping	☐	☐	☐	☐	☐
Forest farming	☐	☐	☐	☐	☐
Silvopasture practices	☐	☐	☐	☐	☐
Windbreaks	☐	☐	☐	☐	☐
Keyline design	☐	☐	☐	☐	☐
Wildlife benefits of agroforestry	☐	☐	☐	☐	☐
Riparian and upland forest buffers	☐	☐	☐	☐	☐
Agroforestry and biomass production	☐	☐	☐	☐	☐
Marketing agroforestry products	☐	☐	☐	☐	☐
Agroforestry economics and financial tools	☐	☐	☐	☐	☐

Timber stand improvement	☐	☐	☐	☐	☐
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4. Use of Agroforestry Curriculum materials

<i>How do you plan to use the content from this training?</i>	Definitely will use	May use	Not likely to use
In classroom lessons	☐	☐	☐
To inform the Supervised Agricultural Experience Program	☐	☐	☐
To enhance FFA content and to advise student career paths	☐	☐	☐
In your own farming practices	☐	☐	☐
Other_____	☐	☐	☐

6. Curriculum modification

For many teachers, the curriculum implementation process includes modification to provided materials. In general, which of the following describes your curriculum modification tendencies? Check all that apply.

I modify curriculum materials in order to...

- ☐ Provide more up-to-date information to my students
- ☐ Include more hands-on activities and project-based lessons
- ☐ Overlap with my own interests
- ☐ Make use of textbooks and other formatted materials
- ☐ Tailor the curriculum to agriculture practices in my region
- ☐ Best suit my teaching methodology:
 - ☐ For greater use of technology (PowerPoints, student computers)
 - ☐ For greater peer-to-peer learning (group problem-solving)
 - ☐ For maximized use of school materials

Thank you for participating in the 2016 Agroforestry Summer Institute

We look forward to hearing from you next spring about your use of the agroforestry curriculum materials!

Please contact Hannah Hemmelgarn, hlh5h8@mail.missouri.edu if you have any questions, comments, or interest in further resources.

F. Self-efficacy: Curriculum implementation Questionnaire
(Delivered via Qualtrics)

Please respond carefully and honestly to the following items related to how capable you feel to accomplish each item in your classroom program.

What is your level of capability to...

	No Capability	--	Very Little Capability	--	Some Capability	--	Quite a Bit of Capability	--	A Great Deal of Capability
Motivate students to learn	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manage student behavior	☐	☐	☐	☐	☐	☐	☐	☐	☐
Use a variety of teaching techniques	☐	☐	☐	☐	☐	☐	☐	☐	☐
Teach students to think critically	☐	☐	☐	☐	☐	☐	☐	☐	☐
Create lesson plans for instruction	☐	☐	☐	☐	☐	☐	☐	☐	☐
Respond to difficult questions from my students	☐	☐	☐	☐	☐	☐	☐	☐	☐
	No Capability	--	Very Little Capability	--	Some Capability	--	Quite a Bit of Capability	--	A Great Deal of Capability
Craft good questions for my students	☐	☐	☐	☐	☐	☐	☐	☐	☐

Adjust lessons for individual students	☐	☐	☐	☐	☐	☐	☐	☐	☐
Evaluate student learning	☐	☐	☐	☐	☐	☐	☐	☐	☐
Use a variety of assessment strategies	☐	☐	☐	☐	☐	☐	☐	☐	☐
Provide alternative explanations when students are confused	☐	☐	☐	☐	☐	☐	☐	☐	☐
Implement alternative teaching strategies in my classroom	☐	☐	☐	☐	☐	☐	☐	☐	☐
	No Capability	--	Very Little Capability	--	Some Capability	--	Quite a Bit of Capability	--	A Great Deal of Capability
Provide appropriate challenges for very capable students	☐	☐	☐	☐	☐	☐	☐	☐	☐
Teach students with special needs	☐	☐	☐	☐	☐	☐	☐	☐	☐
Utilize computers in my teaching	☐	☐	☐	☐	☐	☐	☐	☐	☐
Utilize emerging technologies in my teaching	☐	☐	☐	☐	☐	☐	☐	☐	☐
Utilize a variety of resources in my teaching	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manage a horticulture laboratory/ greenhouse	☐	☐	☐	☐	☐	☐	☐	☐	☐

	No Capability	--	Very Little Capability	--	Some Capability	--	Quite a Bit of Capability	--	A Great Deal of Capability
Implement an Agriscience curriculum in a coherent sequence	☐	☐	☐	☐	☐	☐	☐	☐	☐
Manage an agricultural mechanics laboratory	☐	☐	☐	☐	☐	☐	☐	☐	☐
Effectively conduct field trips	☐	☐	☐	☐	☐	☐	☐	☐	☐
Utilize a Program Advisory Board	☐	☐	☐	☐	☐	☐	☐	☐	☐
Integrate current advances in agriculture technology into the curriculum	☐	☐	☐	☐	☐	☐	☐	☐	☐
	No Capability	--	Very Little Capability	--	Some Capability	--	Quite a Bit of Capability	--	A Great Deal of Capability
Teach knowledge and skills related to Power Structural & Technical Systems	☐	☐	☐	☐	☐	☐	☐	☐	☐
Teach knowledge and skills related to Food Products & Processing Systems	☐	☐	☐	☐	☐	☐	☐	☐	☐
Agricultural Mechanics throughout the coherent sequence of courses	☐	☐	☐	☐	☐	☐	☐	☐	☐
Teach knowledge and skills related to Forest Systems	☐	☐	☐	☐	☐	☐	☐	☐	☐
	No Capability	--	Very Little Capability	--	Some Capability	--	Quite a Bit of Capability	--	A Great Deal of Capability

Please respond carefully and honestly to the following items related to how capable you feel to accomplish each item in your SAE program.

What is your level of capability to...

	No Capability	--	Very Little Capability	--	Some Capability	--	Quite a Bit of Capability	--	A Great Deal of Capability
Provide career exploration opportunities for students	☐	☐	☐	☐	☐	☐	☐	☐	☐

Develop SAE opportunities for students	☐	☐	☐	☐	☐	☐	☐	☐	☐
Motivate students to have an SAE program	☐	☐	☐	☐	☐	☐	☐	☐	☐
Supervise student entrepreneurship SAE programs	☐	☐	☐	☐	☐	☐	☐	☐	☐
Supervise student placement SAE programs	☐	☐	☐	☐	☐	☐	☐	☐	☐
	No Capability	--	Very Little Capability	--	Some Capability	--	Quite a Bit of Capability	--	A Great Deal of Capability
Supervise student production SAE programs	☐	☐	☐	☐	☐	☐	☐	☐	☐
Conduct home/ SAE visits	☐	☐	☐	☐	☐	☐	☐	☐	☐
Make recommendations for students' SAE projects	☐	☐	☐	☐	☐	☐	☐	☐	☐
Utilize resources to make recommendations to students' SAE projects	☐	☐	☐	☐	☐	☐	☐	☐	☐
Assist students in keeping SAE records	☐	☐	☐	☐	☐	☐	☐	☐	☐
	No Capability	--	Very Little Capability	--	Some Capability	--	Quite a Bit of Capability	--	A Great Deal of Capability
Utilize the community to develop SAE opportunities for students	☐	☐	☐	☐	☐	☐	☐	☐	☐
Show students the value of SAE programs	☐	☐	☐	☐	☐	☐	☐	☐	☐
Assist students in receiving recognition for SAE projects	☐	☐	☐	☐	☐	☐	☐	☐	☐
	No Capability	--	Very Little Capability	--	Some Capability	--	Quite a Bit of Capability	--	A Great Deal of Capability

In what contexts did you use content from the Agroforestry Summer Institute (June, 2016) this school year? Check all that apply.

I used the Agroforestry Summer Institute content...

- ☐ In new classroom lessons
- ☐ In adapted classroom lessons (modified versions of previously planned lessons)
- ☐ To inform Supervised Agricultural Experience projects
- ☐ To advise student career paths
- ☐ In my own farming practices
- ☐ Other
- ☐ None of the above

How much time did you spend in class this school year on each of the following items?

	None	Less than 1 hour	1-3 hours	More than 3 hours
Creating an agroforestry plan	☐	☐	☐	☐
Alley cropping	☐	☐	☐	☐
Forest farming	☐	☐	☐	☐
Silvopasture practices	☐	☐	☐	☐
Windbreaks	☐	☐	☐	☐
Keyline design	☐	☐	☐	☐
Wildlife benefits of agroforestry	☐	☐	☐	☐
Riparian and upland forest buffers	☐	☐	☐	☐
Agroforestry and biomass production	☐	☐	☐	☐
Marketing agroforestry products	☐	☐	☐	☐
Agroforestry economics and financial tools	☐	☐	☐	☐
Timber stand improvement	☐	☐	☐	☐
Advising agroforestry-related SAE project(s)	☐	☐	☐	☐

Did you employ any of the lesson components from the provided agroforestry lesson plans in your class this year?

- ☐ Yes
- ☐ Yes, but modified
- ☐ No

If you did employ any of the agroforestry lesson plan components or modified versions of the lesson plan components, please describe what you did below.
Please include a description of any activities, assessments, resources, or content material you used in your class or for SAE.

Please tell us a little about yourself. As a reminder, all information you provide is confidential.

What is your sex?

- ☐ Male
- ☐ Female

What is your birth date? (mm/dd/yyyy)

How many years have you been teaching high school agriculture?

- 1 year
- 2 years
- 3 years
- 4 years
- 5 years
- 6 years

What is the best number to reach you if a follow-up interview is requested?

G. Self-efficacy: Curriculum implementation Interview guiding questions

Agroforestry curriculum implementation and teacher self-efficacy
(Tentative relationship) interview questions

PI: Hannah Hemmelgarn (interviewer)

Advisor: Michael Gold

Hello,

Review of research purpose and question from consent document

Verify verbal consent

Teacher self-efficacy:

1) During your training and education as an agriculture teacher, what kind of verbal confirmation of encouragement did you receive from your peers or mentors?

a) How do you think this verbal encouragement influenced your teaching practices at that time, and long-term?

b) Were any of those words of encouragement particularly powerful for helping you to feel capable and confident in the classroom?

2) Do you receive as much verbal encouragement in this stage of your teaching career?

a) Who provides this feedback, how regularly do you receive this encouragement?

b) Do you notice that you feel more confident and capable in the classroom after hearing these words?

3) How often do you feel challenged in the classroom to complete an unfamiliar task?

a) Can you give me an example of an occasion or two when this happened recently?

b) When you complete these tasks (content-oriented or classroom management-oriented), do you feel more or less confident with your teaching abilities, and why?

c) How do you think these novel experiences have shifted your teaching practices throughout your career, considering that these experiences may have been more frequent earlier in your career?

4) How often do you observe other agricultural educators teaching?

a) Do you feel that you gain any insights from these experiences? If so, describe these benefits.

b) How did these experiences impact your teaching early in your career or during your teacher training?

PDP curriculum content implementation:

1) How has your school year been going? Any particular hurdles or achievements?

a) Have you had any flexibility in this year's course work given the demands of agricultural educators?

b) If so, how have you chosen to alter your curriculum content this year?

- 2) How many courses do you currently teach?
- a) How much time do you feel you have to spend in planning for each of these courses?
 - b) What kinds of activities do you do when you're planning for a course or lesson?
- 3) Your participation in this research is related to your participation in the 2016 Agroforestry Summer Institute. I'm curious to know if you were able to use any of those materials in your classes this year?
- a) In which classes did you use the materials and/or content?
 - b) Did the content flow well with the other subject areas you included in the class or lesson?
 - c) Do you feel confident or uncertain about teaching this content?
 - d) Do you anticipate that you will feel more or less confident teaching this content next year, if you plan to do so? Why?
- 4) What particular subject areas within the content covered during the PDP have you found to be most useful and least useful to you in your classes?