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Michigan School-Based Agricultural Educators' Attitudes, Beliefs and Knowledge of Sustainable Agriculture

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Abstract

Agriculture, food and natural resources systems are stressed to adapt to meet societal, industrial, and institutional pressures of the 21st century and ensure the long-term viability of these sectors. Michigan's abundant natural resource base positions the production of food, fiber, and energy sectors to continue leading the economic revival of the state and remains a critical part of its economic future. However, the use of these natural resources for agricultural and food systems must take into consideration economic, environmental and societal factors in order for these systems to be sustainable. While necessary skill-sets and knowledge are changing for those entering food, fiber, and energy sectors, little research exists regarding Michigan school based agricultural education (SBAE) teachers' perceptions of sustainable agriculture (SA). The purpose of this descriptive/correlation study was to establish a baseline of attitudes, beliefs, and knowledge of SA among Michigan SBAE teachers. A survey measured SBAE teachers' ecological paradigm, agricultural paradigm, knowledge of SA and demographics. In general, SBAE teachers held an anthropocentric worldview, held a more alternative agricultural paradigm, and demonstrated a strong understanding of SA as defined by the United States Department of Agriculture.

Keywords: Sustainable agriculture; School-based agricultural education; Sustainable agriculture attitudes, beliefs, knowledge

1. Introduction

While Michigan's overall economy was severely impacted during the last recession, an economic impact study indicated Michigan's production of food, fiber, and energy sectors underwent a direct economic increase of 45.9% from 2004 to 2010 (Knudson & Peterson, 2012). This is an indication that Michigan's abundant agriculture and natural resource base can be foundational to the state's overall economic well being going forward. However, adverse environmental impacts, such as agriculture's contribution to harmful algae blooms in Lake Erie, demonstrate the requirement to balance economic well-being with sound environmental practices (Scavia et al., 2016).The long-term reliance on agriculture points to the critical need that Michigan's natural resource base be managed in a sustainable way to provide similar economic opportunities for future generations. Sustainable agriculture (SA) is both a philosophy and a system of farming. It is rooted in a set of values that reflects an awareness of both ecological and social realities, and a commitment to respond appropriately to that awareness (MacRae, Henning, & Hill, 1993, p. 22).Beus and Dunlap (1991) contrast this with the conventional agricultural paradigm, worldview that supports economic efficiency through concentration, specialization, mechanized agriculture, and biotechnology. The nation's agricultural and natural resource sectors have the opportunity to address sustainable food and fiber production problems domestically and internationally. However, solutions to meet these urgent food, fiber, and fuel needs are complex and impacted by issues beyond the control of a single nation or economic sector (NRC, 2009, p. 2).

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These issues include providing food for a growing population, negotiating food production with climate change, and managing resources for food and biofuel. Agriculturalists must adapt in order for agriculture to become sustainable (NCAE, 2009).Concomitantly, agricultural education at all levels (K through post-secondary) must adjust to better prepare agriculturalists to address the grand challenges of the 21st century (NRC, 2009). These societal changes are directly impacting the expectations of students in school based agricultural education (SBAE) programs. The National Agriculture, Food, and Natural Resources (AFNR) Career Cluster Content Standards developed by The National Council for Agricultural Education reflect its mission to identify and resolve contemporary national issues (NCAE, 2009). Embedded throughout the standards are the principles of sustainability. For example, in Plant Systems, one performance indicator is "PS.03.04 Performance Indicator: Apply principles and practices of sustainable agriculture to plant production" (NCAE, 2009, p. 53).Sustainable agriculture practices are those technical processes associated with the entire production cycle used as possible ways to help mitigate social, economic, and environmental impacts. Furthermore, the Career and Technical Education framework for the AFNR Career Cluster targets three areas: (a) knowledge and skill statements,(b) Common Career Technical Core Standards (CCTC),and (c) Green and Sustainability Standards. The CCTC standards are a set of voluntary standards that explicitly list the identified knowledge and skills needed for success. One of the six standards for the AFNR Career Cluster calls for students to be able to "analyze the interaction among AFNR systems in the production, processing and management of food, fiber and fuel and the sustainable use of natural resources" in order to succeed in a global economy (National Association of State Directors of Career Technical Education Consortium/National Career Technical Education Foundation, 2012, p. 4). The Green and Sustainability standards were created to assist CTE students in remaining competitive in response to increasing global green-related economic activity. AFNR is one of the career clusters with their own set of green standards. These standards include:(a) decision-making regarding social, economic, and environmental impacts; (b) thinking both globally and locally; (c) inviting community participation; (d) managing natural resources; and (e) considering how the agricultural sector is changing in response to the need for green industry. The inclusion of these standards reflects the need for agriculturalists with these skill-sets, knowledge, values, and beliefs.

1.1 Problem Statement

School Based Agricultural Education teachers in Michigan are faced with educating a workforce to have the skill-sets, knowledge, attitudes, values, and experiences to lead Michigan's food and fiber systems toward a more sustainable paradigm that encompasses environmental awareness while growing the economy in a socially equitable manner. Additionally, there is national pressure to integrate SA education within state academic and CTE standards in SBAE instruction. Therefore, it would be beneficial to establish a baseline of Michigan SBAE teachers' attitudes, beliefs, and knowledge regarding SA.

2. Purpose and Research Questions

The purpose of this study was to establish baseline attitudes, beliefs, and knowledge of sustainable agriculture among Michigan SBAE teachers. The following research questions were used to guide this study.

1. What are the ecological attitudes of SBAE teachers toward SA as measured by the New Ecological Paradigm (NEP)?
2. What are the beliefs of SBAE teachers about SA as measured by the Alternative-Conventional Agricultural Paradigm (ACAP)?
3. What knowledge do SBAE teachers possess of SA as measured by the "Sustainable Agriculture: Principles and Concept Overview" cognitive test?
4. What relationships exist between SBAE teachers' scores on the three scales (NEP, ACAP, and SA cognitive test)?

3. Theoretical Framework

Beus and Dunlap (1991) theorized a separate and disparate paradigm has emerged from the dominant paradigm of conventional agriculture. They suggested proponents of SA subscribe to a fundamentally different alternative paradigm. The authors constructed a body of research which argued: (a) SA concepts represent two greater paradigms,(b) the emerging paradigm (alternative agriculture) did reflect a greater worldview among the population, and (c) fundamental difference between the two paradigms exist (1991,1994a).

Hawcroft and Milfont (2009) suggested attitudes, beliefs, and perceptions relate to behavior and those behaviors can be predicted by constructs such as environmental attitudes. Beus and Dunlap (1994b) suggested there is a relationship between agricultural paradigm and behavior. Comer, Ekanem, Muhammad, Singh, and Tegegne (1999) found those who self-labeled as sustainable agriculturalists utilized twice as many sustainable production practices, a significant difference from conventional agriculturalists.

Udoto and Flowers (2001) argued it is necessary for agricultural educators to place value on SA curricula in order to effectively transform student behavior and convey new knowledge. However, minimal research has been conducted on school-based agriculture educators' attitude, beliefs or knowledge of SA. The limited research available indicates secondary agricultural educators have neutral (Agbaje et al., 2001) to somewhat positive perceptions of sustainability (Muma et al., 2010; Williams & Wise, 1997).

3.1 New Ecological Paradigm

The New Ecological Paradigm (NEP) has been recognized as a measure of environmental attitudes (EA) on the relationship between humans and the environment; it measures the degree that one views the world "ecologically" (Dunlap, 2008). Environmental attitudes have been defined as the "psychological tendency that [was] expressed by evaluating perceptions of or beliefs regarding the natural environment, including factors affecting its quality, with some degree of favor or disfavor" (Milfont, 2007, p. 12). The scale has been widely used both nationally and internationally. Dunlap and Van Liere (1978) argued a separate environmental paradigm had emerged several decades ago that was independent from the so-called Dominant Social Paradigm (DSP), which was fundamentally different in how humans thought about their relationship to and their value of the environment. They recognized three central concepts around which the paradigms were in opposition: (a) limits to growth, (b) balance of nature, and (c) antianthropocentrism (Dunlap & Van Liere, 1978). Dunlap et al. defined anthropocentrism as "the belief that nature exists primarily for human use and has no inherent value of its own" (2000, p. 431). A significant asset of the NEP wasits uniqueness, that it measured worldview rather than specific environmental problems or concerns (e.g., towards pollution) unlike many EA scales (Dunlap, Van Liere, Mertig, & Jones, 2000).

In Dunlap et al., (2000) the researchers modified the scale with two additional concepts: "rejection of exemptionalism" and the "possibility of ecocrisis." Additionally, Dunlap et al. (2000) renamed the New Ecological Paradigm and updated the 15-item scale to maintain the strong reliability and validity of its predecessors (Hawcroft&Milfont, 2009). NEP scores existed on a continuum, which ranged from 15 to 75. Scores on the lower end of the spectrum indicated support, in which one views the human relationship with the environment more anthropocentrically. Scores on the higher end of the spectrum indicate support of more ecological conceptions of that relationship.

While the NEP has been used in research on a global scale, no studies were found that utilized the NEP with SBAE teachers. One international study targeted pre-service teachers in Australia, Indonesia, and the Republic of Maldives. Watson and Halse (2005) reported pre-service teacher NEP means were as follows: 1) Australians (M=60.0); 2) Indonesians (M=55.7); and 3) Maldivians (M=51.6).

3.2 Alternative-Conventional Agricultural Paradigm

The Alternative-Conventional Agricultural Paradigm (ACAP) measures the degree one generally views agriculture ecologically. Similar to the NEP, researchers who constructed the ACAP observed a fundamentally disparate paradigm regarding agriculture had emerged from the existing one (Beus& Dunlap, 1990). The scale was created to understand the values and beliefs that differed between paradigms in regards to the controversies that existed around agriculture (Beus& Dunlap, 1990). The existing paradigm, termed conventional agriculture, involves a "capital-intensive, large-scale, highly mechanized agriculture with monocultures of crops and extensive use of synthetic fertilizers, herbicides and pesticides, with intensive animal husbandry" (Knorr & Watkins, 1984, p. 37).

In contrast, Beus and Dunlap (1990) suggested alternative agriculture, based on their observations, included a philosophical component and an array of alternative goals such as:(a) organic practices as possible, (b) reduced chemical inputs, (c) reduced energy use, and (d) greater farm self-sufficiency. The six defining elements differentiating the agricultural paradigms were (a) centralization versus decentralization, (b) competition versus community, (c) dependence versus independence, (d) domination of nature versus harmony with nature, (e) specialization versus diversity, and (f) exploitation versus restraint (Beus& Dunlap, 1990). The scale demonstrated considerable known-group validity and internal consistency (Beus& Dunlap, 1991).

ACAP scores exist on a continuum with scores on the lower end of the spectrum indicating support for the conventional agricultural paradigm, in which one considers relationships between humans and nature as more anthropocentric. Scores higher on the spectrum indicate support for the alternative agricultural paradigm and value fundamentally different relationships between humans and the environment. Beus and Dunlap found faculty to have more of a conventional paradigm than farmers (1992). Very few studies have used the ACAP with agricultural educators.

Muma et al. (2010) surveyed high school agricultural educators using a modified ACAP to measure their beliefs about SA. After language alterations, the removal of the bipolar item-statements, and the removal of 4 items, the modified scale had a Cranach's alpha value of.82 (Muma et al., 2010). On a scale from one to five with five being strongly agree with the alternative agricultural paradigm, educators reported they slightly agreed (M=3.66; SD=.43) with the beliefs statements about SA (Muma et al., 2010). Teachers reported strong beliefs in sustainability's three components: (a) social, (b) economic, and (c) environmental. Their beliefs toward social and environmental components of SA were stronger than beliefs of economic ones (Muma et al., 2010). Warner, Murphrey, Lawver, Baker and Lindner (2014) also modified the ACAP and used it to determine the agricultural paradigm of Florida Extension agents. Respondents were classified into three categories: (a) conventional, (b) moderates, and (c) sustainable. They concluded there was no disconnect between University of Florida Extension faculty and Extension's goals related to SA.

Researchers often used the ACAP to explore possible relationships between SA and behavior. Allen and Bernhardt (1995) helped to legitimize the ACAP by linking Nebraskan producers' paradigms to their use of conventional or alternative production practices. Comer et al. (1999) suggested those who self-labeled as sustainable agriculturalists utilized twice as many sustainable production practices, a statistically significant difference from their conventional agriculturalist counterparts.

3.3 SARE's "Sustainable Agriculture: Principles and Concept Overview" Cognitive Test

Scales measuring knowledge of SA are limited and tend to consist of Likert scale questions in which subjects report perceived knowledge of specific sustainable agriculture practices (Udoto& Flowers, 2001; Williams, 2000; Williams & Wise, 1997) rather than their actual knowledge. The USDA's Sustainable Agriculture Research and Education (SARE) program partnered with extension to construct The Sustainable Agriculture: Principles and Concept Overview course. The course included a cognitive exam, which measured the fundamentals of SA knowledge.

4. Methods and Procedures

This descriptive-correlational study utilized survey research methodology to determine the attitudes, beliefs, and knowledge of SA among Michigan SBAE teachers. The on-line survey consisted of the following existing scales: (a) the NEP (Dunlap et al., 2000); (b) the ACAP (Muma et al.,2010); and(c) the Sustainable Agriculture: Principles and Concept Overview (SARE) knowledge questions as well as a demographic section.

Instrumentation

The New Ecological Paradigm (NEP) measures how "ecologically" one generally views the world and serves as an indicator of one's level of environmental concern (Dunlap, 2008). The NEP consists of five subscales in addition to an overall score. The five subscales include: (a) limits to growth,(b) the balance of nature,(c) ant anthropocentrism, (d) rejection of exemptionalism, and (e) the possibility of ecocrisis (Dunlap et al., 2000). NEP scores range from 15 (highly anthropocentric worldview) to 75 (highly ecological worldview).

Scores on the lower end of the spectrum indicate support of the Dominant Social Paradigm (DSP) in which one views the human relationship with the environment more anthropocentrically. Scores on the higher end of the spectrum indicate support of the New Ecological Paradigm (NEP) in which conceptions of that relationship are more ecological.

The NEP has been the most commonly used ecological attitude measure with research conducted among domestic and international populations. The NEP's focus on general ecological attitudes has been one of its strengths; it has allowed researchers to understand a population's worldview, whereas other scales have tended to be more specific in scope (Hawcroft & Milfont, 2009). Iterations of the scale have demonstrated strong construct and content validity across different populations (Dunlap et al., 2000; Hawcroft & Milfont, 2009).

The original ACAP scale measured attitudes specifically about agriculture, or the degreeone generally viewed agriculture from an ecological perspective. Muma et al. (2010) modified the scale to measure beliefs, rather than attitudes; their 20-point scale's reliability ranged between .82 and .95. Consequently, for this study, subjects' agricultural paradigm was measured using the Mumaet al. (2010) modified ACAP. For the present study, respondents' knowledge of SA fundamentals was measured using a cognitive test created by the USDA SARE Program. The SARE exam on Sustainable Agriculture: Principles and Concept Overviews a non-credit course available on the eXtension online campus. The cognitive test was selected as a measure of SA knowledge because SARE's conceptualization of SA has shaped their outreach and grant funding programs in working with agricultural professionals and extension.

Ten true/false questions were selected from the test's complete bank of 48 questions, which addressed the fundamental importance of the economic, social, and environmental components of SA. The reliability, face validity, and content validity of the three scales were established through a panel of five experts in the Department of Community Sustainability (CSUS) at Michigan State University (MSU). The three scales and the demographics section were placed into a single on-line survey using Qualtrics. The resulting survey was then pilot tested with the panel of experts, senior-year pre-service SBAE students, SBAE interns, and graduate students in the CSUS at MSU. Internal reliability was determined using Cronbach's alpha for the NEP (.72) and the ACAP (.82). Kuder-Richardsons 20 (KR-20) was used to determine the internal reliability of the cognitive test (SARE). One item was removed which increased the scale's internal reliability considerably to .70. Bivariate Pearson Correlations were used to obtain test-retest reliability for the ACAP; concerns about test-retest reliability resulted in the removal of 6 items.

The population frame was obtained from the Michigan State FFA Association. The resulting population frame consisted of 104 agricultural educators. Given the low number of teachers in Michigan it was decided to conduct a census. Instrument construction and correspondence with subjects followed Dillman's Tailored Design Method to maximize response rates(Dillman, Smyth, & Christian, 2009). All teachers were informed that survey participants would be entered into a randomized raffle to receive one of three $50 Amazon gift cards.

A census of the population was notified via email of the upcoming study and that they would receive an email invitation to participate. All remaining electronic correspondence was personalized to maximize response rates (Dillman et al., 2009). Ten days later, the population was emailed regarding information about the research and an invitation to participate in the survey via a web link. Those who did not initially respond were sent up to three reminders. The reminders were emailed from the Michigan Department of Education supervisor for SBAE.A total of 50 surveys were collected for a response rate of 45%.Non-response error was addressed by selecting a random sample of 30 non-respondents from the population frame who were contacted by phone (Bethlehem, Cobben, &Schouten, 2011). A combination of the call back approach (Hansen & Hurwitz, 1946) and basic question approach (Bethlehemet al., 2011) was used. Fourteen non-respondents participated in the non-response follow-up.

The phone survey consisted of the NEP and ACAP to determine whether non-respondents exhibited any significant differences in their agricultural and ecological worldview from survey respondents. Independent t-tests compared the summed NEP and ACAP means of survey respondents (n = 50) to those contacted by phone (n = 14) to determine whether there were any differences in the worldviews of non-respondents. No significant differences existed between groups regarding their worldviews (ACAP,p=.55; NEP,p= .67).Known demographic traits were also compared between non-respondents and survey respondents. AChi-squaretest was used to determine whether response was the result of chance or not in terms of demographics. Teaching region was not associated with higher response rates (X^2=1.48; p=.92).It was concluded that non-respondents were not different from respondents in their ecological and agricultural paradigm and findings could be generalized to the population.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) (version 19.0). Where correlations were reported, effect size was estimated as follows: (a) a strong correlation for Pearson (r) values between ± 0.50 and ± 1.00; (b) a moderate correlation for (r) values between ± 0.30 and ± 0.50; and (c) a weak correlation for (r) values between 0 and ± 0.30 (Cohen, 1992).Pearson's Correlational Coefficient was used to test relationships between the three scales: (a) NEP and ACAP;(b) NEP and SARE; and (c) ACAP and SARE.

The NEP and the ACAP consist of a summated five-point Likert scale, which measured agreement. Agreements with the seven even NEP scale items favor the dominant social paradigm; scores for these seven scale items were reversed. NEP scores could range from 15 to 75 with higher scores reflecting deeper adherence to the new ecological paradigm. One incomplete NEP response was omitted from the data set. ACAP scores could range from 14 to 70 with higher scores reflecting deeper adherence to the alternative agricultural paradigm.

For responses with missing data, a mean of the existing values was obtained for the number of responses completed. The cognitive test (SARE) provided four possible responses to each SA statement and obtains a correct response (value of 1) or incorrect response (value of 0). The responses were summated with a possible range of scores from 0 to 9. A reliability analysis among survey respondents revealed a KR-20 of .63. As a cognitive test with a set of correct responses, missing data were treated as incorrect (value of 0).

5. Results

Data contained in Table 1 present frequency distribution of subjects' responses to the NEP. Respondents' (n=47) mean NEP score was 49.6 (SD = 8.70) with a minimum of 22 and a maximum of 71.This is an indication that Michigan SBAE teachers tend to have more of an anthropocentric worldview when compared to other studies. However, the standard deviation of 8.7 along with the range of a minimum of 22 to a maximum of 71 indicated very different ecological worldviews among the respondents. For example, 34% of respondents agreed or strongly agreed "humans have the right to modify the natural environment to suit their needs" while 44% disagreed or strongly disagreed. Overall, respondents (96%) agreed with item nine that "humans are subject to the laws of nature." No other item produced a higher agreement than two-thirds of respondents (66%).The ACAP was used to measure beliefs around agriculture. The scale measures the degree respondents generally view agriculture ecologically. ACAP Items 13 and 14 support a conventional worldview of agriculture and were reverse coded to obtain the ACAP mean. The respondents' (n = 48) mean composite ACAP score was 53.1 (SD = 5.24) with a minimum score of 34 and a maximum score of 62 out of a possible range of 14 to 70.

The ACAP scale item data were presented in terms of means and frequency distributions; the presentation of item means is in accordance with (Jackson-Smith &Buttel, 2003; Muma et al., 2010) data presentation from the literature (Table 2). When the ACAP data were broken down by individual scale item, respondents consistently held a strong alternative agricultural worldview. There was almost universal agreement on five of the 14 scale items. All respondents agreed that the "development of healthy soils is important for SA" and that "SA conserves natural resources for the benefit of future generations." Ninety-eight percent of respondents agreed or strongly agreed "SA promotes recycling of renewable natural resources" and that "local farming practice impacts success of SA."Ninety-four percent of respondents agreed or strongly agreed "crop rotation is important to achieving SA." Additionally, respondents strongly disagreed or disagreed with scale items less than 10% of the time with the exception of three scale items.

Table 1: Means, Standard Deviations, and Frequency Distributions for NEP Scale Items (n=47)

				Responses				
	NEP Scale Items	M	SD	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	We are approaching the limit of the number of people that the earth can support.	3.4	1.23	3 (6%)	10 (21%)	10 (21%)	14 (30%)	10 (21%)
2	Humans have the right to modify the natural environment to suit their needs.	2.9	1.06	3 (6%)	18 (38%)	10 (21%)	14 (30%)	2 (4%)
3	When humans interfere with nature, it often produces disastrous consequences.	3.5	1.02	1 (2%)	7 (15%)	16 (34%)	15 (32%)	8 (17%)
4	Human ingenuity will ensure that we do not make the earth unlivable.	3.3	0.90	0 (0%)	11 (23%)	15 (32%)	18 (38%)	3 (6%)
5	Humans are severely abusing the environment.	3.3	1.22	4 (9%)	8 (17%)	12 (26%)	14 (30%)	9 (19%)
6	The earth has plenty of natural resources if we just learn how to develop them.	3.4	1.07	1 (2%)	11 (23%)	12 (26%)	16 (34%)	7 (15%)
7	Plants and animals have as much right as humans to exist.	3.3	1.11	2 (4%)	9 (19%)	16 (34%)	12 (26%)	8 (17%)
8	The balance of nature is strong enough to cope with the impacts of modern industrial nations.	2.5	1.04	5 (11%)	24 (51%)	8 (17%)	8 (17%)	2 (4%)
9	Despite our special abilities, humans are still subject to the laws of nature.	4.2	0.48	0 (0%)	0 (0%)	2 (4%)	35 (75%)	10 (21%)
10	The so-called "ecological crisis" facing humankind has been greatly exaggerated.	2.9	1.10	4 (9%)	16 (34%)	12 (26%)	12 (26%)	3 (6%)
11	The earth is like a spaceship with very limited room and resources.	3.5	1.04	1 (2%)	9 (19%)	12 (26%)	18 (38%)	7 (15%)
12	Humans were meant to rule over the rest of nature.	3.0	1.13	6 (13%)	9 (19%)	15 (32%)	14 (30%)	3 (6%)
13	The balance of nature is very delicate and easily upset.	3.7	0.80	1 (2%)	1 (2%)	14 (30%)	25 (53%)	6 (13%)
14	Humans will eventually learn enough about how nature works to be able to control it.	2.6	0.82	2 (4%)	22 (47%)	15 (32%)	8 (17%)	0 (0%)
15	If things continue on their present course, we will soon experience a major ecological catastrophe.	3.3	1.04	2 (4%)	9 (19%)	15 (32%)	16 (34%)	5 (11%)

Note. Full Prompt: Based on your own ATTITUDES, please indicate to what extent you AGREE with the following statements. Even number items are not reversed coded in table but were in determining total NEP score.

Even the three exceptions were not disagreed with more than thirty percent of the time. The three exceptions were: (a) 29% disagreed that "the size of a community impacts development of SA;" (b) 19% disagreed that "SA reduces need for external sources of inputs;" and (c) 17% disagreed that 'local knowledge of farming in a community is an indication of sustainability in agriculture." Overall, SBAE teachers believed in a more sustainable worldview of agriculture. That worldview included believing almost universally agriculture was about: (a) the centrality of building up healthy soil; (b) the conservation of both renewable and non-renewable resources for the future; (c) the significance of crop rotation; and (d) that agriculture uses and values practices generated from and by farmers.

There were two items in which respondents held a more conventional agricultural worldview. Nearly three-quarters of respondents agreed with the two scale items that supported the conventional agricultural paradigm "SA promotes specialized crop and livestock enterprises" and "innovations in agricultural technology determine the success of SA." Disagreement with both occurred less than 10% of the time.In other words, SBAE teachers believed agriculture consisted of a foundation of new technology to support it and specialization in terms of both crops and livestock. SBAE teachers consistently held a strong conventional agricultural paradigm regarding both specialized crop and livestock enterprises and innovations in agricultural technology. Respondents' (n = 48) had mean SAP cognitive test scores of 7.3 (81% correct) with a standard deviation of 1.7 and a minimum of one and a maximum of nine.

Table 2: Means, Standard Deviations, and Frequency Distributions for ACAP Scale Items (n = 48)

	ACAP Scale Items	M	SD	Responses				
				Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Development of healthy soils is important for SA	4.7	0.45	0 (0%)	0 (0%)	0 (0%)	13 (27%)	35 (73%)
2	SA conserves natural resources for the benefit of future generations	4.7	0.47	0 (0%)	0 (0%)	0 (0%)	15 (31%)	33 (69%)
3	Crop rotation is important to achieving SA	4.4	0.61	0 (0%)	0 (0%)	3 (6%)	24 (50%)	21 (44%)
4	SA promotes recycling of renewable natural resources	4.5	0.55	0 (0%)	0 (0%)	1 (2%)	21 (44%)	26 (54%)
5	Exchange of knowledge about locally designed technologies among producers promotes SAP	4.1	0.80	1 (2%)	0 (0%)	6 (13%)	25 (52%)	16 (33%)
6	Integrating diverse crops with livestock enterprises promotes SA	4.0	0.81	1 (2%)	0 (0%)	10 (21%)	25 (52%)	12 (25%)
7	Local farming practice impacts success of SA	4.4	0.62	0 (0%)	1 (2%)	0 (0%)	24 (50%)	23 (48%)
8	The size of a community impacts development of SA	3.3	1.26	4 (8%)	10 (21%)	11 (23%)	13 (27%)	10 (21%)
9	SA promotes local processing of agricultural production	3.9	0.80	1 (2%)	0 (0%)	13 (27%)	25 (52%)	9 (19%)
10	Local knowledge of farming in a community is an indication of sustainability in agriculture	3.7	0.98	0 (0%)	8 (17%)	10 (21%)	21 (44%)	9 (19%)
11	SA reduces need for external sources of inputs	3.4	1.08	3 (6%)	6 (13%)	16 (33%)	16 (33%)	7 (15%)
12	SA promotes local marketing of agricultural production	3.7	0.89	1 (2%)	1 (2%)	18 (38%)	18 (38%)	10 (21%)
13	SA promotes specialized crop and livestock enterprises[a]	3.8	0.69	0 (0%)	2 (4%)	12 (25%)	29 (60%)	5 (10%)
14	Innovations in agricultural technology determine the success of SA[a]	3.9	0.92	0 (0%)	4 (8%)	10 (21%)	20 (42%)	14 (29%)

Note.[a]Agreement with these statements support a more conventional worldview of agriculture

SBAE teachers' generally high scores indicated they were fairly knowledgeable about SA fundamentals, meaning they understood the values of SA relative to the balance of social, economic, and ecological factors. SBAE teachers' Cognitive Test frequencies and percentages provided baseline information about assumptions toward SA based on correct and incorrect responses for individual scale items (Table 3). For each item, four statements regarding SA were presented; respondents were asked to select the one true statement. Respondents were somewhat consistent in accuracy of responses; correct responses ranged from 72 to 94 percent.

Individual scale responses indicated educators recognized SA necessitates balancing the generation of revenue with environmental integrity; however, fewer educators recognized economic viability as a tenet essential to SA. This characterization is reflected from the fact that nearly all respondents correctly answered item five (94%) that "stewardship of natural resources is critical to SA"and item eight (92%) that "farms and ranches need to be both profitable and environmentally sound" (Table 3). SBAE teachers almost universally recognized SA involved an ecological component (e.g., natural resources).

Respondents recognized SA involved a balance between economic and ecological concerns. Twenty eight percent of respondents were incorrect about "farms and ranches need to be profitable to be sustainable" (Item 1) and "SA involves developing new methods that protectfarm resources while maintaining economic viability" (Item 3). These results suggested SBAE teachers had difficulty recognizing SA is dependent upon economic profitability.

Table 3: Frequency Distribution for Cognitive Test by Scale Item (n=47)

	Which of the following are true?	Correct		Incorrect	
		N	%	n	%
1	Farms and ranches need to be profitable to be sustainable	34	72	13	28
2	The site specific nature of SA makes farmer knowledge and experience critical to long term success	37	79	10	21
3	SA involves developing new methods that protect farm resources while maintaining economic viability	34	72	13	28
4	Many different kinds of farms can be sustainable	36	77	11	23
5	Stewardship of natural resources is critical to SA	44	94	3	6
6	The different components of the agricultural system, like production and marketing, affect each other	39	83	8	17
7	The transition to SA is a long-term, dynamic process	38	81	9	19
8	Farms and ranches need to be both profitable and environmentally sound	43	92	4	8
9	SA is producer-centered, but it encompasses issues related to the whole food system	36	77	11	23

Some SBAE teachers struggled to understand the versatility ofSA in terms of production scale and systems or the vastness of the systems involved. Almost a quarter of respondents(23%) did not recognizeSA is adaptable and flexible to varying production scales and systems as indicated by "many different kinds of farms can be sustainable" (Table 3, Item 4).An equal number of SBAE teachers didnot recognize SA involved making decisions about social, environmental, and economic factors at multiple levels as shown by"SA is producer-centered, but it encompasses issues related to the whole food system" (Item 9).Seventeen percent of respondents answered item 6 incorrectly that "different components of the agricultural system, like production and marketing, affect each other.

Pearson's Correlational Coefficient tested for the presence of relationships between NEP, ACAP, and cognitive test scores (Table 4). A weak, positive relationship emerged between NEP and ACAP (r=.21)and a very weak, inverse relationship emerged between NEP and the cognitive test (r=-.11).No relationship existed between the ACAP and the cognitive test. SBAE teachers who tended to value a more ecological relationship with nature, tended to also have values toward agriculture that were more ecological as well. Agricultural worldview was not associated with respondents' knowledge of SA.

Table 4: Pearson's Correlation of Relationships between Ecological Paradigm, Agricultural Paradigm, and Knowledge of SA

	NEP	ACAP	SA Knowledge
NEP	-		
ACAP	.21	-	
SA Knowledge	-.11	.04	-

6. Conclusions

SBAE teachers in Michigan as a whole reported a more anthropocentric worldview on the NEP scale (M=49.6; SD=8.70) than found in other populations. However, overall there was a divided ecological worldview among respondents. SBAE teachers collectively and consistently, held a weak or divided ecological worldview with the only agreement being that "we as humans were operating within the confines of nature's laws," "nature's workings can be easily disrupted," and" nature can succumb to the effects of our industrialized world."Overall, some teachers were strongly anthropocentric as evidenced by a score of 22 while some had an extremely strong ecological worldview as indicated by a maximum score of 71. Approximately one-third of the respondents were more neutral with their view.

Evidence of a more anthropocentric view was that half of the respondents agreed "human ingenuity will ensure that we do not make the earth unlivable." Furthermore,nearly half of respondents agreed or strongly agreed "the earth has plenty of natural resources if we just learn how to develop them."The clearest indication of a bivariate population in terms of NEP was that close to half the respondents (44%) strongly disagreed or disagreed that "humans have the right to modify the natural environment to suit their needs," while approximately a third agreed they do have the right to modify the environment.

While research has not targeted agricultural educators to determine their ecological worldview using the NEP, Michigan SBAE teachers had a more anthropocentric worldview of the environment in comparison to many other populations in the literature. Their worldview is more anthropocentric than the international pre-service student teachers targeted by Watson and Halse (2005). Watson and Halse (2005) found the group of international student teachers scored significantly differently from those of the other countries: (a) Australians (M = 60.0); (b) Indonesians (M= 55.7); and (c) Maldivians (M= 51.6). All of the countries examined had more of an ecological worldview than Michigan SBAE teachers.

In this study, beliefs about humans' role in the balance of nature were nuanced. However, nearly all respondents shared the view that humans must operate within the laws of nature. Research by Hunter and Rinner (2004) experienced similar results within their sample. Conversely, Michigan SBAE teachers strongly believed nature is fragile and can be disturbed, particularly by the consequences of our industrial world. Many believed human interactions with nature often result in dangerous outcomes, however a strong number believed contrary to this statement. It appeared that while these possibilities exist to some extent, educators have faith in humans to rectify these situations. Many SBAE teachers felt very strongly that human ingenuity will continue to make the earth livable and could develop resources for the future.

Respondents reported a strong alternative agricultural worldview (M=53.1; SD=5.24). There was near universal agreement on five of the 14 scale items: (a) 100% agreed "development of healthy soils is important for SA;" (b) 100% agreed "SA conserves natural resources for the benefit of future generations;" (c) 98% agreed "SA promotes recycling of renewable natural resources;" (d) 98% agreed "local farming practice impacts success of SA;" and (e)94% agreed "crop rotation is important to achieving SA."

Michigan SBAE teachers' strong belief in a more alternative agricultural paradigm was somewhat at odds compared to their anthropocentric worldview of the environment in general in comparison to other studies. Michigan SBAE teachers had some very clear views in their beliefs about agriculture. Despite demographic differences, they believed building up healthy soils is vital to agriculture and envision crop rotation as key to part of that process. SBAE teachers believed in an agricultural worldview where resources are carefully managed; where it's necessary to conserve natural resources, and recycle renewable ones.

They also shared the belief that the agricultural worldview encourages individual farming practices, which hasn't been the tradition this century with direction from Extension (Warner et al., 2014). MichiganSBAE teachers were divided in the extent they believed community size has any bearing on the outcome of agriculture or that agriculture can reduce external inputs. Interestingly, they were also divided in their belief that a community's knowledge of farming was part of agriculture. MichiganSBAE teachers were also strongly united in their beliefs that agriculture includes crop and livestock specialization and innovative agricultural technology, typically associated with a more conventional belief system.

In comparison to Muma et al. (2010), MichiganSBAE teachers held a similar agricultural worldview to the high school agriculture educators surveyed throughout the NCR (North Central Region – SARE), which included Michigan teachers. In comparison to Beus and Dunlap (1992), MichiganSBAE teachers held a more alternative agricultural paradigm than Washington State faculty, groups of identified Washington conventional agriculturalists, and Washington State farmers.

Michigan SBAE teachers had a working knowledge of SA as indicated by their scores on the cognitive test. They were especially knowledgeable in the area dealing with environmental sustainability. For example, almost all correctly answered that stewardship of natural resources is critical to SA. However, the respondents were not as knowledgeable regarding economic sustainability. The two items most frequently answered incorrectly were "farms and ranches need to be profitable to be sustainable" (28%) and "SA involves… protect[ing] farm resources while maintaining economic viability" (28%). Both position economic profitability as fundamental to sustainability.

Too often the term sustainability is only associated with environmental issues when economic and cultural aspects are equally important to a sustainable agricultural system. Evidence SBAE teachers were also less knowledgeable regarding the cultural importance of sustainability was that a quarter did not think different types of farms could be sustainable; a quarter did not think SA involved issues spanning the entire food system, and one-fifth did not think "farmer knowledge and experience [were] critical to long-term success of SA."

Overall Michigan SBAE teachers had a clear understanding of the fundamentals and concepts of SA. SBAE teachers' understanding matches what is being taught and promoted through SARE to Extension and agricultural professionals. However, respondents were not as knowledgeable that an economically viable farm or ranch was a fundamental and necessary component of SA. This is consistent with the findings of Muma et al. (2010) where economic knowledge was also lacking. Another area respondents were unclear was they saw SA being limited to certain types of farms. Many did not recognize the integration of production with the entire food system. The fact that many also did not think "farmer knowledge and experience [were] critical to long-term success of SA" coincides with the belief that farming knowledge being situated within a community.

A weak, positive relationship emerged between NEP and ACAP ($r = .21$) where a SBAE teacher having a stronger ecological worldview tended to believe in more of an alternative agricultural paradigm. One would expect a stronger, more positive relationship between the NEP and ACAP. A possible explanation is that the ACAP should be updated to better reflect many of the agro ecology practices now being implemented on farms. This would provide greater precision to the ACAP and provide more granularity on a subject's agricultural paradigm. The low negative correlation between the NEP and subjects' score on the SA Knowledge test is not consistent with the positive relationship between the NEP and ACAP. It is recommended that a greater number of questions be used in future studies to provide greater reliability.

This research identifies possible additions needed to SBAE curricula in response to the various national standards calling for increased sustainability instruction. Results suggest there be more focused education on economic, environmental, and social components as it relates to agriculture in SBAE programs. Furthermore, since the teachers had divergent beliefs in their ecological world view, there should be courses that provide a greater focus on sustainability as it relates to agriculture, food and natural resources systems. Furthermore, given the complexity of these systems SBAE teachers could also benefit from an introduction to holistic management. There is a need for additional research to better understand attitudes, beliefs, and knowledge about SA with other types of agricultural educators such as Extension agents.

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