Teachers’ Perceptions toward Sustainable Agriculture in an Ohio Science High School

Dissertation

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By

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Abstract

The discussion about the environmental challenges and socio-economic situation connected with conventional agricultural systems in the United States in the 1980s, and sustainable agriculture (SA), has mentioned the role of education in highlighting barriers. Advocates of sustainable agriculture declare that education about SA can present solutions to the current challenges in agriculture, provoke rural economic development, and enhance the scientific teaching of SA (Feldman, 1999). The goal of this study was to describe the perceptions of high school teachers about SA. A census of 17 teachers at the Global Impact STEM Academy (GISA) in Ohio (U.S.A.) was given questionnaires with five-point Likert-type scales and nine teachers responded. Teachers also self-selected into a focus group interview. In addition, a classroom observation was made in which qualitative data were collected.

This study replicated research at Iowa State (Muma, 2006). Based on previous research, Cronbach’s coefficients for the reliability ranged from .74-.95. Quantitative findings indicated GISA teachers’ most common beliefs about SA primarily were food safety, soil testing, water quality, crop rotation and use of animal manure. GISA teachers taught more topics about biological, social and ecological dimensions of SA compared to economic dimensions. The amount of these topics that teachers taught were the lowest compared to row banding of herbicides, narrow strip intercropping, and use of
nitrification inhibitors. Also GISA teachers engaged in moderate instruction about sustainable agriculture in their classes. GISA teachers were in “agreement” about sustainable agriculture belief statements and sustainable agricultural practices. They used a variety of instructional methods for sustainable agriculture including top ranked methods of group discussion, hands-on-learning, project-based inquiry, and websites. The qualitative methods of this study included classroom observation and a focus group. Qualitative findings were generally consistent with the quantitative results for GISA teacher beliefs and educational practices about sustainable agriculture.
Dedication

I dedicate my dissertation work to many friends and family. A special feeling of gratitude to my loving husband, Hiwa, whose words of encouragement were valuable. I also dedicate this dissertation to my many friends who have endorsed me throughout the process. Always I will appreciate all they have done, specifically my wonderful daughter, Dolvan, for being there for me throughout the entire doctorate program.
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Chapter 1: Introduction

Human survival relies on earth’s ecosystems. Therefore, humans utilize natural resources to meet their current needs, while availability of these natural resources for future generations is often forgotten (Chivian & Bernstein, 2008; de Barcellos, Krystallis, de Melo Saab, Kügler, & Grunert, 2011; Macdiarmid, 2013; Robertson & Swinton, 2005; Sitienei & Morrish, 2014; Sustainable Agriculture Research & Education [SARE], 2008). The increasing human population is causing a decline in the availability of natural resources and is diminishing the physical environment. Agricultural systems need to produce enough food for today’s humans, which is currently more than six billion people. Consequently sustainable agriculture production is correlated with food production and environmental effects (Chivian & Bernstein, 2008; Robertson & Swinton, 2005). In addition, biodiversity is explained as the variety of earth’s organisms including populations, species, genes, and different ecosystems (Chivian & Bernstein, 2008).

By appropriately using natural resources such as air, soil, water, and labor, sustainable agriculture may be accomplished (Hobbs, 2007). Sustainable agriculture, globally, needs a multi-disciplinary view in the process of agriculture production (Parr, Trexler, Khanna, & Battisti al., 2007 & Chivian & Bernstein, 2008).

Thus, it is essential to explain sustainable agriculture within the context of an altering agricultural industry. Definitions of sustainable agriculture vary based on different views. For instance, Robertson (2012) wrote that during Jefferson’s era,
Jefferson believed that “the right to make all the use of a thing that can be made without injuring the substance of the thing itself” (2015, p. 76).

Key Points in Applying Sustainable Agriculture

Monitoring of changing ecological environments should be considered when applying sustainable agriculture. In the 1990s, the National Research Council (NRC, 1993) claimed that sustainability was essential to “keep the productive capacity of natural resources in step with population growth and economic demands while protecting and, where necessary, restoring environmental quality” (p. 66). Basically, to apply sustainable agriculture, these points needed to be highlighted:

• Accomplish the assimilation of natural biological periods and controls;
• Conserve soil productivity and the foundation of natural resources;
• Enhance management and utilize on-farm resources;
• Increase the use of sustainable resources and buy inputs;
• Prepare for undependable farm income;
• Encourage family farming and farm organizations;
• Minimize harmful effects of industrialized agriculture on safety, wildlife, water quality, and the environment (Sustainable Agriculture Network, 2002).

Practically, Gliessman’s (1998) study mentioned some of the most common sustainable agriculture techniques that were used by farmers to reach the key goals of erosion control, disease control, weed control, high soil quality, pest control, crop rotation, cover crops, soil enrichment, natural pest predators, and bio-intensive integrated pest management. Communities were encouraged to think about sustainable farming and
the long-term results of practices and their interactions with agricultural systems. It was advocated that these could be achieved by balancing inputs of natural resources. Sustainable agriculture actions were touted as the practices that would eventually lead to the premium management and enhancement of farms ecologically.

There are a variety of ways to enhance the sustainability of agricultural systems and they vary from region to region. Thus, some systems utilize popular ways of applying sustainable agriculture approaches with regard to using local recourses (Sustainable Agricultural Network, 2002). For instance, educators are encouraged to update their information about new research and technology for assisting students in learning more about sustainable agriculture.

Teaching as Transfer of Knowledge

Since students are the next generation of citizens and agriculturalists, investing in the process of teaching is crucial to grasping and adopting sustainable agriculture practices. In fact, teaching is a system of offering expertise and demonstrating approved practices between the teacher, the student, the materials and the topic. Teachers must consider individual student characteristics as well as the learning context in developing student potential for adoption of new content (Udoto, 1999). Furthermore, Whittington (1995) reported that educators have important responsibilities such as educating colleagues on recent teaching issues.

The idea of teaching new topics should be adapted based on today's learning environment and should consider the different trends in agriculture. Mumtaz (2002) suggested that teachers should have a positive view on their topic in order to facilitate the
process of education. High school teachers, therefore have a crucial role in the transfer of agricultural knowledge in the United States.

Teaching Sustainable Agriculture

Parr, et. al (2007) indicated that educational plans need more concentration on sustainable agriculture. Further, to achieve this goal, agriculture teachers require an interdisciplinary approach to connecting isolated social and natural science subjects to the theory and practice of sustainable agriculture. Specific consideration must be given to the content being taught and to the approaches to educational programs that create more clarity and collaboration between the social, economic, environmental, and agricultural systems (Parr, et. al, 2007).

A Theory for Adoption of Sustainable Agriculture

Social Reconstruction Theory is appropriate for framing an exploration of teaching about sustainable agriculture. As a philosophy, social reconstructionism advocates for using critical issues in society as the foundation for writing curriculum that has the potential for creating a better society. Since agricultural sustainability is an important issue facing the ability of society to produce enough food to feed its citizens, and since teachers are a key influence on the students who will be the next generation of citizens, a theory that embraces curriculum as a means for solving societal issues is the appropriate approach for the scientific inquiry.
An Introduction to the Global Impact Stem Academy

The Global Impact Stem Academy (GISA) is a two year old high school with an agricultural context in its approach to curriculum. According to their marketing materials, GISA is

“An early-college high school certified in STEM (science, technology, engineering and mathematics) curriculum and has specialized its core gateways to lead the students from the time they begin high school until they enter college or into specialized professional industries that affect our day-to-day lives. While at GISA, students will encounter interdisciplinary, problem-based learning. They blend every course together into real-world experiences and assignments that push students beyond the classroom and into a meaningful future”

Teaching agbioscience is the foundation of the school curriculum. GISA defines agbioscience as studying living things, cultivation and a scientific way in agriculture. Teachers in GISA concentrate on the agbioscience industry because it is a main business infrastructure in Ohio and is a field that the school considers to be growing significantly. Because of its mission in bioscience fields, GISA provides preparatory educational experiences, training, and skills for students interested in these industries. The school advocates for a curriculum that is hands-on, problem-based, and uses real-world projects to prepare students for experiences in the classroom.

Unique characteristics of the school include: a) students have the opportunity to earn two free years of college coursework, b) students’ first two years includes a 4-course block semester to achieve all required high school classes, c) students move forward into college classes offered through The Ohio State University, Wright State University, Clark
State Community College, Central State University, and Wilmington College, d) internships are available to increase students’ knowledge of careers as well as achieving invaluable experience and training.

GISA obtained grants from contributors during its start-up including The Ohio State University, Battelle, and the Ohio Department of Education.

Statement of the Problem

Agriculture producers have adopted modern agricultural technologies, which play a role in making in the U.S. agriculture market the most efficient and dynamic market in the world. However, increasing modern agriculture has led to degradation of the natural environment (Marlow, Hayes, Soret, Carter, Schwab, & Sabaté, 2009). Because sustainable farming is less conventional than traditional farming practices, to establish sustainable agriculture across the whole system requires full understanding of the many social, economic, and environmental benefits of sustainable agriculture systems (Seufert, Ramankutty & Foley, 2012).

Education is fundamental for evolving sustainable agriculture systems. By infusing agricultural sustainability into society, a sustainable food supply may exist for the future (Bissonnette & Contento, 2001). High school students, as the next generation of American citizens, have the potential to be the next generation of sustainability experts in society. Therefore, high school teachers are a key variable in introducing, engaging, and influencing the adoption of sustainable agriculture practices.
Purpose of the study

The purpose of this study was to describe perceptions of an Ohio high school teachers toward sustainable agriculture. The specific objectives guiding the study included:

- Describe teachers’ perceptions of sustainable agriculture topics.
- Describe teachers’ perceptions of sustainable agriculture practice.
- Describe the sustainable agriculture topics taught by Global Impact Stem Academy teachers.
- Describe classroom methods used by teachers to teach sustainable agriculture.

Assumptions

The following assumptions were made regarding this study:

Secondary school teachers at GISA have some knowledge of the topic of sustainable agriculture and related practices.

GISA teachers have positive intentions toward integrating sustainable agriculture into their curriculum.

The participants responded to the questions accurately and honestly.

The questionnaires were clear enough for teachers to understand and respond to them accurately according to their perceptions.

Collected data represented the views and the genuine perceptions of the secondary school teachers at GISA.

The findings of this study would help high school teachers at GISA to consider sustainable agriculture in their curriculum.
Need for the Study

This research focused on a two-year old agbioscience high school and its teachers’ perceptions of sustainable agricultural education practices. A social reconstruction theory provided the foundation for describing the teachers’ perceptions toward sustainable agriculture curriculum development and implementation of sustainable agriculture knowledge and practice. As the school adds a new middle school next year, it seeks to inform its topics and methods in addressing societal issues of the community it serves.

Implications and Educational Significance

This study aimed to describe teachers’ perceptions regarding sustainable agriculture and to identify their two components of their perception including their current knowledge and their educational assessment regarding teaching sustainable agriculture. Results of this study can be utilized for the development of high school science teachers toward sustainable agriculture education.

Definition of Terms

In this study, the following constitutive and operational definitions are utilized.

Constitutive Definitions

Sustainable agriculture: Approaches of agricultural systems that are ecologically viewed, environmentally humane, economically applicable, and socially practicable (Williams, 1997).
Agricultural actions: The way of accomplishing the various farming tasks (National Research Council, 1989).

Conventional Agriculture System: Type of farming system that is contingent upon capital-intensive external inputs such as credit, agrochemicals, and energy.

Sustainable Agricultural Practices: Farming practices with economically viable, socially desirable, and environmentally sound (Jayaratne, 2001).

Crop rotation: The process of farming that assists in restoring soil nutrients, prevents crop losses to insects, and decreases erosion by keeping the soil covered by vegetation (Miller, 1998).

Perception: The personal and professional judgments of respondents including an event, issue, concept, or condition based on knowledge and experience (Ajaiyeoba Agbaje, 1998).

Operational definitions

Teachers’ general perception of sustainable agriculture: Quantitative and qualitative data collected from high school teachers at GISA about sustainable agriculture including using natural resources, the impact of the farming practice, the effect of sustainable agriculture, consideration of local farming, farm size, the size of a community, and locally designed technologies.

Practices of science teachers toward sustainable agriculture: Quantitative and qualitative data collected from high school science teachers toward sustainable agriculture that can achieve sustainable agriculture including water quality, recycling agricultural wastes, food safety, protection of wetlands, renewable sources of energy,
wildlife conservation, air pollution, rotational grazing, narrow strip intercropping, fall seeded cover crop, use of low input livestock facilities, row banding of herbicides, soil test, nitrogen application, insect resistant crops, mechanical weeding, reduced rates of herbicides, reduced nitrogen fertilizer rates, use of nitrification inhibitor, reduced tillage, herbicide resistant crops, crop rotation, and animal manure.

Sustainable agriculture teaching methods: Quantitative and qualitative data collected about educational methods that teachers use to deliver sustainable agriculture to students such as lectures, one-on-one instruction, reading assignments, case studies, group discussion, demonstrations, hands-on learning, projects, debates, workshops, field days, videotapes, and websites.
Chapter 2: Literature Review

Gold (2009) revealed that sustainable agriculture is a procedure that attempts to provide the basic needs of current citizens while protecting natural resources for future generations. Gold stated that the United States Department of Agriculture (USDA) committed to working toward environmental, economic, and social sustainability of different forests, foods, fiber, agriculture, and range systems. Gold considered that USDA would make attempts to balance goals of enhanced production and profitability, supervision of the natural resource bases and ecological procedures, and improvement of the vitality of rural societies. According to Gold, USDA should combine these goals into its policies and plans, specifically through partnerships, associations, teaching, and research.

Okeafor (2002) indicated that shifting systems from a monoculture to sustainable agriculture might have some barriers. The author revealed that the sustainable agriculture-working group (SAWG) is a group of people that have an interest in sustainable agriculture. According to his study, this work group, originally comprised of University Outreach and Extension field staff, who have been together for years, collectively utilize a list of forums and an information sharing tool. Recently, he added that these groups have opened discussions to a wider public by extending an invitation to join their Listserve as educators, farmers, or consumers. The writer believed that the goal
was to expand the audience, while enhancing learning, and furthering sustainable agricultural initiatives.

Okeafor (2002) mentioned that Americans nationwide are considering environmental and social issues such as surface and ground water, food safety and quality, pollution, biotechnology, and monitoring the natural resources. He added that soil erosion, boosting international competition, and altering consumer preferences requires a sustainable American agricultural system.

Generally, policy makers prefer one kind of production system. Tegtmeier & Duffy (2004) reported that when one research area is elevated other areas are neglected and this neglect has an effect on our existence. The authors indicated that decreasing of specific species has effects on people’s lives. Keeney (1991) concurred adding that people want to alter the nation’s land ethics since many challenges such as water pollution, soil erosion, decreasing wetlands, and biological diversity are important. Keeney (1991) discussed some approaches that can protect natural resources and provide national or global food security and farm revenue. A report from the Leopold Center (1994) explained that generally farmers utilize three learning techniques including informational learning through showing and collecting of information, observational learning through exploration of on-site farm practices, and experiential learning through implementation, correcting mistakes, and additional action.

Sustainable Agriculture: Definition and Concepts

The Committee for Ecological Agriculture Project (2001) defined sustainable agriculture as a philosophy that has both ecological and social values. This committee
indicated that sustainable agriculture involves design and management programs that work with natural processes to preserve all resources, and minimize environmental damage while maintaining or enhancing farm profitability (Pretty & Hine, 2001).

Keeney (1990) deemed that the disruption of agricultural sustainability supports cooperative growth through long-term minimization of environmental effects and weak social/economic impacts of some of today’s agricultural actions. He clarified the concepts of sustainable agriculture in an attempt to facilitate communication. The author pointed out that finding a definition of sustainability is a time-consuming process during which researchers are acquiring more accurate information for facilitating the meaning of this concept. Tegtmeier and Duffy (2004) stated that the basis of much of U.S. agricultural research is about increasing production and improving efficiency, where efficiency has been measured in terms of output per worker.

Role of Sustainable Agriculture on Agricultural Education

Hillison (1996) showed that agriculture teachers should consider the applications of scientific and research foundations, so they can improve information about agriculture. The National Research Council, in 1988, launched “Reinventing Agricultural Education for the Year 2020” by the National Council for Agricultural Education. It was suggested that agricultural education be required for all students. It was specified that agricultural topics involving natural resources and consumption, production, and processing be strengthened. Policy documents from the national council indicated that the requirements for agricultural education are to develop high school students for “... successful careers and a lifetime of informed choices in the global agriculture, food, fiber
and natural resources...” (p. 2). The National Council for Science and Environment stated that the necessity of formal and non-formal education in assessing solutions to the “... challenges of environmental, social and economic sustainability...” (2003, p. 5). Other studies pointed out the role of curriculum related to sustainable agriculture and indicated that it can alleviate solutions to the current challenges in agriculture, including rural economic development, improving the scientific teaching of agriculture, and enriching work skills for high school graduates (Williams & Dolliso, 1998).

Further, a local movement as well as a global movement advocated for *sustainability education* in the 1990s (Culen & Volk, 2000; UN, 2002, 2005). This movement was begun because of the effect of agriculture on the environment after increasing the human population and the consumption of food. The final goal of sustainable agricultural education was creating citizens who were responsible towards the environment (Muma, 2006).

The agricultural education curriculum was prepared based on sustainable agriculture topics. Infusion of agricultural education with sustainable agriculture helped students to achieve decision-making skills and holistic and integrative management (Williams & Dolliso, 1998). It assists students in conceptualizing different elements of the agricultural systems (Santone, 2003) and can be used for determining an appropriate base for learning agricultural education. In addition, Lee and Thomas believed (1995) that sustainable agriculture penetrates the agricultural education curriculum to enhance agricultural education with wide based science foundations and their implementation.

Integration and application of science among different agricultural and natural resource sciences has been advocated (Conroy & Walker, 2000; Thompson, 2001), as
well as accomplishment (Chiasson & Burnett, 2001; Conroy & Walker; Lee & Thomas, 1995; Shelley-Tolbert, Conroy, & Dailey, 2000; Thompson, 2001) and enrollment (Shelley-Tolbert et al.) in agricultural education.

Sustainable Agriculture Approach

Sustainable agricultural development has risen in the U.S. since the 1980s (Beus & Dunlap, 1990, 1991; Hassanein, 1999). The sustainable agriculture movement has created an approach that focuses on an economic dimension in conventional agriculture tied to farm bankruptcies and environmental challenges in the 1980s, to a system of actions and technologies that combined economic, social, and ecological systems in agriculture (Keeney, 1989; Me Isaac, 1996).

An approach is a combination of personal preferences and societal norms to analyze the meaning of the external world (Beus & Dunlap, 1990). According to the American Society of Agronomy, sustainable agriculture is about improving the lives of farmers and society as a whole (Me Isaac, 1996). Although this definition of sustainable agriculture has been accepted as constituting the most vital elements of sustainable agriculture, the meaning has been highly politicized and has needed a wide implication (Conway, 1997). Both agronomists and economists have the same goal which is protecting the environment while producing an adequate food and fiber supply for residents. Environmentalists and ecologists highlighted the natural resources based on food and fiber production while sociologists focus on encouragement of premium social principles and equitability in fiber and food production. While environmentalists and ecologists agree that sustainable agriculture is a way to produce food and fiber without
damaging non-renewable resources, anthropologists and sociologists explain this concept as an agriculture that protects institutions and social values (Duffy, 1999).

Therefore, sustainable agriculture includes a range of agricultural systems such as organic farming, ecological farming, indigenous technical knowledge, biodiversity, regenerative farming, and integrated pest management among others (Conway, 1997). Sustainable agriculture involves a way of trying to address the technical and socio-economic problems in agricultural systems both from technical and normative approaches. Hence, sustainable agriculture is both a philosophy and a system of agricultural practices (Macrae, et al, 1993).

Sustainability Approach and Farmers’ Action

Farmers are adopting sustainable agriculture slowly in the North Central Region (NCR). Other scholars have also found that farmers are slow adopters of sustainable agriculture practices (Alonge & Martin, 1995; Commer, Ekanem, Muhammad, Singh, & Tegegne, 1999; Conner & Kolodinsky, 1997; Gamon, Harrold, & Creswell, 1994; Koralalage, 2001; Salamon, Farnsworth, Bullock, & Yusuf, 1997). Some studies, however, have shown that farmers have begun shifting their use of traditional and conventional framing practices toward sustainable agricultural practices (Chiappe & Flora, 1998; Commer et al., 1999; Hassanein, 1999; Salamon et al., 1997). Some of the studies have indicated that conventional and sustainable farmers have different views based on socio-economic, attitude, and beliefs.

Alonge and Martin (1995) pointed out that young and adult farmers in Iowa had very positive views toward some activities in sustainable agriculture practices such as the use of green manure soil, spring/summer nitrogen application, and nitrogen testing.
Furthermore, these Iowa farmers had positive perceptions toward the compatibility and profitability of these sustainable actions. Nevertheless, most of the farmers had declared neutral perceptions. Those with neutral perceptions however, were using some sustainable practices such as crop rotation, mechanical weeding, the nitrification inhibitor, decreased herbicides, and nitrogen and fertilizer rates. Earlier studies showed that perceptions and attitudes of farmers had a significant role in adopting conservation practices (Miranowski, 1982).

Gamon et al. (1994) found no statistically significant difference in the adoption of some sustainable cropping systems (cropping, tillage, pest management, and livestock) among Iowa farmers who had attended and those who had not attended two extension conferences on sustainable agriculture. The results of the study showed that the long-term economic profitability of the sustainable practices were a significant factor in practicing sustainable agriculture.

Agricultural Education Research and Educational Planning

Aldo Leopold (1949) introduced the sustainable agriculture paradigm (Beus & Dunlap, 1990). Leopold believed that education is an efficient way to understand the environment and land as a whole (Agbaje et al., 2001). Leopold (1949) “... contended that the educational policy, as well as the content, quality, and quantity of education, are equally important...” (p. 39).

As early as the 1980s, The National Research Council (NRC) (1988) suggested enhancing high school agricultural curriculum in science. Nevertheless, it was not until 1996 that the National Council for Agricultural Education (NCAE) (1996) evolved and
distributed instructional materials to help combine sustainable agriculture into the general high school agricultural education curriculum. Some of the titles included in the new NCAE (1996) agriculture curriculum model were: land use, soil conservation, water and air quality. These changes contributed to integrating sustainable agriculture with the high school agriculture curriculum. Some states such as Wisconsin, Vermont Georgia, California, Michigan, Iowa, and New York developed the agriculture curriculum with more sustainable agriculture content. Some of the products and tools of sustainability curricula that supported teaching and learning about sustainable agriculture curriculum included: software, curriculum, curriculum guides, professional development programs, and green construction projects. In 2003, Vermont was the only state with explicit sustainable agriculture curriculum standards (Santone, 2003).

Attitudes and Sustainable Agriculture and the Environment

Researchers found that curriculum based on current problems can increase information, attitudes, and behavior of learners and cause them to feel more responsibilities toward environmental issues (Federico et al. 2003, Feldman, 1999 and, Muma, 2006). It has been found that youth attitudes toward the environment, and its effect on their environmental behavior is most effective when established early in life (Federico, Cloud, Byrne, & Wheeler, 2003; Francis & King, 1994). Learning activities, including those that incorporate environment issues, can help children transfer learning to other areas (Basile, 2000).
Sustainable Agriculture and Education Programs

Wallace (1993) recommended that educational programs for the public focus on sustainable systems and practices in agriculture. Wallace further suggested that the environment would be a significant element in the development of sustainable agriculture production systems. This would be the case specifically when considering the changes and technical development in sustainable agriculture (Powers, 1994).

The combination of science principles and their implications in teaching agriculture curriculum has increased the value of agricultural education. This has been accomplished through the fact that science principles and implications have improved achievement levels and interests of students who registered in agriculture classes, especially with significant content in agriscience (Chiasson & Burnett, 2001; Conroy & Walker, 2000; Thompson, 2001).

To have reasonable responses to the food and fiber challenges of the 21st century, the National Council for Agricultural Education (1995) suggested that agricultural education teachers update their curriculum. The study of sustainability issues that encourage the use of holistic approaches to education (Vehoviak, Adams, & Bruening, 1994) is viable. Tanners declared, “One way to improve curriculum is using multidisciplinary approaches to structure curriculum to address social problems and needs. Students are facing these problems daily, so they can understand these problems and it can facilitate the process of learning” (1995, p. 391).

This multidisciplinary approach was utilized to strengthen decision-making in the agriculture system. To keep pace with developments in the agricultural industry, infusion of sustainable agriculture into the high school agricultural education curriculum is
necessary. Thus, there is a need to help high school agriculture teachers adjust to the social change such as the sustainable agriculture movement (Williams & Dolliso, 1998). To prepare graduates to work, sustainable agriculture must be included in high school agricultural education programs in the 21st-century food and fiber system (Marshall & Herring, 1991).

Hamilton (1999) deemed that there is great ability in the principles of sustainable agriculture to show the economic and environmental issues facing the agricultural sector. He advocated that if food production systems and the natural resources used to raise food are not grounded in the principles of sustainability, the future is ambiguous. Kirschenmann (1997, as cited in Leopold Center for Sustainable Agriculture, 2000) highlighted that, “one has to become a society of lovers of the soil...” (p. 6).

Williams and Wise (1997) proposed that initial steps must be taken to combine the high school agricultural education curriculum into the newly developed knowledge of sustainable agriculture actions. Instructional assistance, and innovative teaching paradigms are arising from developments in sustainable agriculture that assist students in experiencing sustainable actions. This procedure will facilitate student learning and interest in sustainable agriculture (Feldman, 1999; Francis & King, 1994). Cardwell (1995) applied new curriculum, which included sustainable agriculture. Student connections with the applied sciences in the food and fiber system in high school agricultural education, can provide a unique desirable situation to improve instruction with technology and science.
Contextual Teaching and Learning

The U.S. Department of Education (USDE) and the National School-to-Work Office (2002) emphasized that any educational plan that changes the mind should be focused on excellent learning and teaching. It is deemed that contextual teaching and learning means: focuses on problem-solving, realization of the requirement for teaching and learning to take place in a different of frameworks including the home, society, and work sites, and teaching students to control and find their own learning. As a result, they become self-monitored learners, and anchor teaching in students' diverse life-contexts.

The USDE defined contextual teaching and learning as a term of teaching and learning that assists teachers to connecting subject matter to real-world circumstances. These circumstances persuade students to make connections between awareness and its performances in their lives as workers, family members, and residents. This model suggests that teacher education programs require building general agreement around basic approaches, purposes of the education program, and the role of the mission of schools and the teacher, regarding the nature of teaching and learning in a democratic environment. The model recommends that educational plans and curriculum should engage the development of skills.

Connection between Sustainability and Agricultural Education

Understanding the role of sustainable agriculture content in the agriculture curriculum is probably one of the requirements of the teachers, students, and society about the agriculture industry. Additionally, the role that teachers with basic knowledge about sustainable agriculture play in the connection between beliefs about sustainable
agriculture and other variables, could be a factor in students accepting the notion of agricultural sustainability (Muma, 2006).

When examining curriculum needs of high school teachers, it is essential that teachers recognize the effect of sustainable agriculture philosophies on the sustainable agriculture curriculum (Udoto & Flowers, 2001). This can be gained by: encouraging students to engage, incorporating relevant content for student interests; promoting student cognitive and affective improvement through engagement with the environment (Moore, 1977) social responsibility for a healthy environment, and involvement in learning about sustainable systems (Jaus, 1984).

Sustainable Agriculture Curriculum

The National Council for Agricultural Education, for the first time, developed a nationally adopted curriculum in 1996 to help in integrating sustainable agriculture into the high school agriculture materials. Some of the topics in natural resource areas were air quality, land use, soil conservation, and water quality. After this introduction of curriculum, agriculture teachers began adopting the content and states started to integrate sustainable agriculture into the state-wide standards.

Some of the barriers that were experienced when integrating sustainable agriculture curriculum into agricultural education were deficiency of determined sustainable agriculture technologies from land-grant universities, teacher qualifications for teaching sustainable agriculture, lack of instructional skills for teaching sustainable agriculture, textbooks on sustainable agriculture, and deficiency of marketing of potential sustainable courses (Conroy, 2000).
Borsari (2005) suggested that to be truly effective, a curriculum must be designed to meet more “... pragmatic and social needs...” (p. 99). Borsari continued that, “... participation of and motivation of students are necessary ingredients to implement appropriate curricular changes...” (p. 99).

Social Reconstruction Theory

Essentially, Social Reconstruction Theory is utilized in schools and education as the central part of social, political, and economic development (McNeil, 1996). The theory highlights the goal of education and focuses on interests of the individual and society. Further, it displays that social needs should be the foundation of teaching and learning, curriculum development, and evaluation. Therefore, social reconstruction theory considers school curriculum as the tool for achieving proper and moral development for the society. The theory presumes that all members of a community have responsibility for the control of all resources such as natural resources and social institutions. The theory posits the development of related attitudes from learning and action to social interests is a crucial result of education. All areas of study are beneficial for learning.

Social Reconstruction Theory suggests that individuals, through using critical societal questions as a naturally occurring catalyst for learning, are able to achieve knowledge and skills needed for solving real-world challenges. In this scheme, focusing on teaching members of society and building consensus among learners and members of the society is critical. Based on the theory, learning opportunities must be selected on the foundations of satisfying three circumstances: being real, needing action, and teaching social values connected to the society’s goals toward solving problems (Giroux, 1987).
According to Social Reconstruction Theory, school curriculum should be utilized to teach learners about different problems facing them and the human community. In a curriculum model inspired by Social Reconstruction Theory, teachers can understand social problems and can assist students in solving them through applications of critical questions. Realization of students’ interests leads to achieving their goals. This model can prepare students with the motivation to learn more about real-world problems (Dewey, 1938; McNeil, 1996, 2006). Further, willing societies can use their resources to promote students in hands-on learning.

Researchers have agreed that a district-wide approach to education will assist students in engaging in curriculum and instruction in terms of linking economic, social, and ecological systems (Santone, 2003). This approach, using social reconstruction philosophy, will help students to realize the current and sustainable agriculture actions and the interactions of sustainable agricultural systems with the wider physical, biological, and social systems (Francis & King, 1994) present in schools and communities. Designing agricultural curriculum around societal critical questions, encourages students to consider learning environments and educational methods that focus on decision-making, problem-solving, active learning, higher-order thinking, collaboration, diversity, problem-based learning, and interpersonal communication. Such higher cognitive, STEM curriculum, designed in a social reconstruction philosophy, can close the gap between the urban United States population and sustainable agriculture. Through an applied social reconstruction philosophy, the population has the potential to acquire agricultural literacy through a curriculum that informs critical societal questions (Cardwell, 1995; Feldman, 1999; Hubert, Frank, & Igo, 2000).
Because youth often have the capacity to connect with nature and generally have positive perceptions toward the environment, they can be the effect on educational interventions (Jaus, 1984; Moore, 1977). Therefore, high school teachers should consider Social Reconstruction Theory infused approaches for teaching sustainable agriculture content to enhance the agricultural education curriculum (Borsari, 2001; Firebaugh, 1990).

It must also be considered, though, that social reconstruction perspective is criticized for a number of reasons. According to McNeil (1996, 2006) deficiency of solutions from academic curriculum plagues reconstructionism. In addition, the problem of depicting interpretations from a curricular versus a scientific approach, receives skepticism (Liu & Matthews, 2005; Tam, 2000).

Analysis of Dewey’s social reconstruction theories of educational philosophy, however, show that the following thought that can be created through reconstructionism: learning is fundamental in meaningful experiences; experience is information built up by members of a society; a community of learners share educational experiences and make collective knowledge (learning is systems based); and social attitudes and values rely on the learning aims adopted for education. Other arguments in favor of Social Reconstruction Theory are: experiential learning causes higher-order learning; associating learning to particular societal needs and the environment is important to the quality of learning; significant learning happens when approaches let knowledge flow from experience; and assessment of learning is participatory (Tam, 2000).
Conceptual Framework

Social Reconstruction theory and the sustainable agriculture curriculum model (McNeil, 1996) provided the foundation for the conceptual framework for this study. The curriculum model is a scheme for learning, outlining at least the learning goals/objectives, subject, actions, and evaluation (McNeil, 1996, 2006; Posner, 1997, 2005; Tanner & Tanner, 1995) while the theory advocates for a societal driven, hands-on, problem solving approach.

Therefore, the study focused on describing the teachers in a new agbioscience school where sustainable agriculture was a philosophical intention in the district-wide curriculum. Social Reconstruction Theory was used to recognize the connections between agbioscience teachers’ perceptions of sustainable agriculture and the topics taught and methods used for teaching sustainable agriculture in the district-wide curriculum.
Chapter 3: Methodology

Purpose of the study

The purpose of this study was to describe perceptions of Ohio high school teachers toward sustainable agriculture. The specific objectives guiding the study included:

- Describe teachers’ perceptions of sustainable agriculture topics.
- Describe teachers’ perceptions of sustainable agriculture practice.
- Describe the sustainable agriculture topics taught by Global Impact Stem Academy teachers.
- Describe classroom methods used by teachers to teach sustainable agriculture.

Population and Sample

The research was a case study involving a census of the teachers (N=17) of the Global Impact Stem Academy (GISA). This two-year old high school, in Springfield, Ohio, is an early-college high school concentrated on STEM (science, technology, engineering, and mathematics) curriculum in agbioscience. The school has specialized in an area through encouraging students to enter college or enter specialized professional industries that have impact on their daily lives. Although students in GISA are following problem-based interdisciplinary learning, the school combines every course together into real-world assignments that promote furthering the classroom into a meaningful future.
Since this research is a census, all teachers in GISA high school who were listed in the 2016 directory were provided with questionnaires (N = 17). Ten questionnaires were returned, but one was unusable (n = 9).

Research Context

The research was designed to measure participant GISA perceptions of sustainable agriculture. Questionnaires were used to receive immediate, independent perceptions, while a semi-structured interview (focus group) and a classroom observation were used to add understanding and clarity. The research received IRB approval (#2016E0649).

Research Design

A positivist research paradigm informed the researcher. Therefore, a descriptive research design was utilized to accomplish the objectives. A deductive approach was used for the purpose of describing. Since this research was a descriptive study of the experiences of GISA high school teachers, an agriculture-based agbioscience high school, framed within the Social Reconstruction Theory, a mixed methods research design was appropriate. Teachers self-selected to participate in the experience. Teachers were not randomly selected or assigned to treatments which limited the ability to generalize the findings beyond the GISA teachers whom responded to the survey and whom participated in the focus group or were observed in his/her classroom.

Another reason for choosing mixed methods was so numbers and narrative could both be used for clarity (Johnson & Onwuegbuzie, 2004). According to Tashakkori and
Teddlie (2003) mixed method studies combine qualitative and quantitative approaches in one study. Tashakkori and Teddlie further stated that mixed methods allow for understanding experiences. Because the study was mixed methods, there were multiple approaches to data collection and analysis. Both quantitative and qualitative approaches were used to gain detailed knowledge about GISA teachers’ perceptions of sustainable agriculture. Ritchie and Ormston (2013) explained that quantitative research methods provided breadth of information about the topic while qualitative research methods developed depth of information. Analyzing the data collected from both methods answered research questions while offering a strong resource to inform and illustrate practice.

The qualitative portion of the study required the researcher to begin with a broad view, perspective, and assumptions, and then to determine objectives (Creswell, 2007). These research objectives then allow the researcher to collect data based on an issue or phenomenon, and to analyze the data for patterns, before generating results that can be utilized to extend the literature or advise an action (Creswell, 2007; Glesne, 2006; Patton, 2002). Additionally, Glesne (2006) explained that “qualitative studies are best at contributing to a greater understanding of perceptions, attitudes, and processes” (p. 29). Qualitative research methods were additionally chosen to address the Social Reconstruction theory framework. According to Creswell (2007), the researcher-developed descriptions of the teachers’ experiences about sustainable agriculture contributed to the structural curriculum descriptions, conveying a general essence of the experience. Creswell’s description aligns appropriately with the theoretical framework of the study.
Instrumentation: Quantitative

The quantitative portion of the study utilized a questionnaire that consisted of four scales and a number of scale items (in parenthesis) as follows: sustainable agriculture concept statements (20); perceptions of sustainable agricultural practices (21); the extent to which sustainable agriculture topics are taught in the agriculture curriculum (25); and the extent to which different teaching methods are used for teaching sustainable agriculture (13). Generally, the sustainable agriculture beliefs and perceptions of selected sustainable agriculture scales were highlighted. The sustainable agriculture topics/practices covered the four natural resource areas of soil, water, agro forests, and air; consist of their uses and technologies (Borsari, 2001; Okeafor, 2002). The final section of the questionnaire provided respondents’ demographic data such as level of education, gender, and how long teachers had been teaching. All instrument scales were 5-point Likert-type scales. Twenty factors were utilized to measure Global Impact STEM Academy teachers’ beliefs on sustainable agriculture practices (Alternative-Conventional Agriculture Paradigm Scale) (Beus & Dunlap, 1991, 1994).

The ACAP scales consisted of six elements (centralization, independence, community, diversity, coordinate with nature, and caution) that show insights of sustainable agriculture (Chiappe & Flora, 1998; Flora, 1990). The elements of the sustainable agriculture philosophies have impact on social, economic, and ecological characteristics of sustainable agriculture (Agbaje et al., 2001; Alonge & Martin, 1995; Williams & Wise, 1997). Perceptions about sustainable agriculture practices scales for measuring sustainable agriculture philosophies were from 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree, to 5 = strongly agree. The scales measured the selected
sustainable agriculture topics that were contained in science curriculum as well as various educational methods that the GISA teachers used to teach sustainable agriculture topics (Likert scale from 1 = none; 2 = low extent; 3 = moderate extent; 4 = high extent, to 5 = very high extent).

Validity and Reliability of the Instrument

Validity of the instrument was established by generating factors of sustainable agriculture from references in the research literature. (Agbaje et al., 2001; Hasannein, 1999; Hassanein & Kloppenburg, 1995; Kloppenburg, Henrickson, & Stevenson, 1996; Okeafor, 2002; Udoto & Flowers, 2001; Williams, 2000). Utilization of the related literature in the instrument was assumed to provide internal validity for the instrument. A relatively high validity for the instrument was displayed by the relatively high-reliability estimates asserted by Cronbach’s coefficients (Ary et al., 2002, Muma, 2006). Content validity of the instrument was established by including the suitable number of elements that provided a variety of traits or factors representative of the literature from the research in each scale. The number of elements contained in each scale was approximately 20 elements. This ensured the scale variables were determined accurately from multiple views (Lawler, 1967; McMillan & Schumacher, 2001, Muma, 2004).

The population responding to the questionnaire, participating in the focus group interview, and/or allowing the researchers to observe in the classroom is representative of the high school GISA teachers. This study did not have any response error where people involved in the census do not provide meaningful answers and are different on facets of interest to the research than the target population (Lindner et al., 2001). This study did
not have Non-response error (Armstrong & Overton, 1977; Lindner et al., 2001). This study occurred at the end of the fall semester of 2016 and the beginning of spring semester of 2017.

Methods of Data Collection for the Quantitative Portion of the Study

For the quantitative portion of the study, the questionnaire for the study was given to every teacher accompanied by an introductory letter signed by the researcher (Appendix A). Clear instructions for completion of each section of the questionnaire were provided to respondents. The informed consent letter, approved by the Institutional Review Board at The Ohio State University (Appendix C), explained the purpose of the survey and the human subjects’ rights to the respondents.

Analysis and Organization of Data

The tasks in the data analysis for the quantitative portion of the study focused on the following:

1. Summarizing the data into measures of central tendency to describe the teachers’ perceptions toward sustainable agriculture.

2. Summarizing the data into measures of central tendency to describe the teachers’ practice toward sustainable agriculture.

3. Describing the data as measures of frequency and central tendency to explain the subjects’ methods of teaching sustainable agriculture.

4. Summarizing the data into measures of frequency and central tendency to explain the demographic characteristics of the subjects.
Data were organized based on the research objectives. Data were analyzed by means, standard deviations, and medians; descriptive statistics were used since this was a census study. No inferential statistics were appropriate.

Methodology for the Qualitative Portion of the Study

The qualitative portion of the research was a descriptive, qualitative case study research design using a semi-structured interview (focus group with N = 17 participants) and a classroom observation as the primary sources of data collection. In addition, qualitative research methods were conducted using semi-structured interview techniques for following reasons: Interviewing is a flexible method to collect data from different types of information including personal narratives, views and opinions, factual data, and histories that can answer a wide range of questions. The interviewers have an opportunity to clarify and understand the questions. The interview interaction encourages participants to talk more about their answers. However, the researcher did not forget the ethical research framework and, therefore honored the guarantee of confidentiality by handling the data in an ethical manner (Wallace & British Educational Research Association, 2012).

*Gaining access.* Gaining access refers to the researcher’s acquisition of consent to go where one wants, talk to whomever one wants, and obtain the information wanted for the study (Yin, 2014). The researcher followed the procedures outlined by Glesne (1999) to gain access with each participant by guaranteeing confidentiality and anonymity prior to data collection. An initial meeting was arranged with the district director via a phone call to the director’s office. The population of teachers was asked to sign a consent form
to indicate their willingness to participate in the study. To guarantee confidentiality and anonymity, the researcher had participants use only a course assigned number when submitting work associated to the study. The researcher also assured participants that their names would never be connected with their numbers for any reason during the study.

All data for the qualitative portion of the study were collected across a one-hour focus group. The researcher communicated, in advance, the potential need for further discussion and assistance in the future, including a review of the interview report for the member check.

*Qualitative instrumentation.* The instrument included a code book protocol of three definition questions in part one and three open-ended questions in part two. The panel of experts, consisting of professors and graduate students with expertise in qualitative research, reviewed the code book protocol. Edits were made per feedback from the panel of experts. The instrument provided opportunity for an in-depth examination of the teachers’ perceptions of sustainable agriculture. A classroom observation was made using a qualitative observation technique. These multiple sources of data collection were imperative to a case study design (Creswell, 2013).

*Group interview protocols.* A group interviews (focus group) was conducted spring semester where teachers were asked questions related to defining and implementing sustainable agriculture practices in their classroom teaching. The semi-structured interviews lasted for approximately 60 minutes. It was monitored by two graduate students with experience in focus group protocols. Teachers were first asked to individually reflect on their experiences, by completing a personal written reflection with
guided questions. Once teachers completed their personal reflections, each of the guided questions were asked aloud by the monitors of the group interview protocol.

*Data management and analysis.* All data were securely handled. Recordings of the group interview, having received permission from the participants, were stored in the researcher’s computer files. The electronically-recorded interviews were transcribed, word-for-word. The transcriptions were modified based on comments received during the member check, and the documents were stored in the researcher’s secured computer files.

The initial analysis of the data involved coding of the participant interview transcripts, and reading and coding. Themes that emerged were coded accordingly.

*Role of the researcher.* The study was conducted from interpretivism epistemology. Interpretivism assumed that realities were socially constructed by participants in the study and that variables were complex and interwoven (Glesne, 1999). Thus, the researchers served as the data collection instrument and meanings were created through the researcher’s interpretation of the participants’ realities (Schwandt, 2000). The data gathered from participants were filtered through the feelings and experiences of the researcher as the data collection instrument to generate the complete data for the study (Patton, 1990).

*Ethical considerations.* The researcher committed to the guidelines outlined by Christians (2000). Thus, informed consent was established by providing full and open information about the study. Participants were also informed, both orally and in writing, that their participation or non-participation would have no effect on course outcomes. Teachers were also made aware that by participating in the study, they were agreeing to have their reflections and interviews saved anonymously for data analysis. Participants
also knew that they could choose to not respond to a particular question. The researcher avoided deception by being honest with participants about their status and the purpose of the research. The researcher guaranteed privacy and confidentiality to all participants, by tracking all data with assigned numbers instead of names. A member check was conducted to ensure that participants felt the information they provided was accurately reported.

*Trustworthiness of the study.* Trustworthiness was explained by Lincoln and Guba (1985) as encompassing the conventional components of internal validity, external validity, reliability, and objectivity. Lincoln and Guba proposed that conventional measures of quality were not appropriate for qualitative inquiries, and that the measure of trustworthiness was appropriate. The components of trustworthiness included credibility, transferability, dependability, and confirmability.

Credibility, or the likelihood that credible findings and interpretations were produced, was addressed in the study by using methods outlined by Lincoln and Guba (1985). Triangulation, the use of multiple sources of data collection methods, was guaranteed by utilizing multiple sources to corroborate findings. Finally, member checks were conducted with participants in the study to ensure that what was reported accurately represented the information provided. Through the member check process, copies of the interview transcriptions were sent to participants to allow the opportunity to review and make adjustments, before the data were analyzed.

Transferability addressed the question, “How can one determine the degree to which the findings of an inquiry have applicability in other contexts or with other respondents?” (Lincoln & Guba, 1985, p. 218). The current study provided a thick
description allowing other researchers to decide if making a transfer between the current study and future studies is possible. A thick description referred to providing enough evidence of the study to allow readers to determine if transferability of findings is possible.

Dependability and confirmability were established through an analysis of the audit trail maintained by the researcher. Dependability referred to the likelihood of the findings being repeated if the study was replicated with the same participants in the same environments. Confirmability ensured that the findings reflected the characteristics of the participants in the given setting, not the biases, motivations, interests and perspectives of the researcher (Lincoln & Guba, 1985).

Limitations of the Study
The following limitations were observed regarding this study:
1. The findings of the study are limited to teachers at GISA who participated in various aspects of the study.
2. Results cannot be generalized beyond the findings which targeted this one-of-a-kind Ohio agbioscience high school and its teachers.

Assumptions of the Study
The following assumptions were made regarding the study:
1. The instrument and scales constructed for measuring the variables important to the research were valid, reliable and, therefore appropriate for the measurement of the variables/constructs that have been researched.
2. All high school teachers in GISA read and understood the questions on the questionnaire in the same way and were equally knowledgeable in providing responses to questions. That is, each question item measured all the responses accurately and validly.

3. All teachers in GISA were technically knowledgeable about sustainable agriculture practices, and were able to teach students about selected sustainable agriculture topics.
Chapter 4: Findings

Chapter Four is written to describe the findings of the data collection procedures and to share the analysis of the quantitative and qualitative data. A summary of the three main components of the instrument and the one demographic component of the instrument are presented. Overall, the chapter is focuses on the data analysis of a new agbioscience high school and its teachers’ perceptions of sustainable agricultural education. A social reconstruction theory provided the foundation for describing the teachers’ perceptions toward sustainable agriculture curriculum development and implementation of sustainable agriculture knowledge and practice.

Because this is a census study, descriptive statistics such as means, standard deviations, medians, frequencies and percentages are reported for the research objectives. No inferential statistics are appropriate for the purpose of this study. The purpose of this study was to describe high school teachers’ perceptions toward sustainable agricultural education at the Global Impact Stem Academy in Ohio. The study described teachers’ perceptions, practices, topics and teaching methods toward sustainable agriculture. Additionally, the study described the following demographic data of the respondents: gender, undergraduate major, highest level of education reached, and the number of years of teaching.
In this study, members of the research team were divided between two groups. One group visited a class, which was about environmental microbiology in an independent laboratory learning environment. The second group facilitated a focus group interview with the GISA teachers. In order to increase trustworthiness, two main researchers did not participate in the focus group interview protocol. Researchers outside of the current study conducted the focus group interview.

Findings: Quantitative

Demographic Data

Among the census 17 high school teachers in the GISA school system in the study, 10 of them returned questionnaires for the survey (1 was unusable), eight (88.9%) were female and one (11.1%) was male.

![Distribution of respondents by gender](image)

Figure 1: Distribution of respondents by gender
For *highest degree obtained*, most teachers in GISA had obtained a Master’s degree (n = 7) and two earned a Bachelor’s degrees. Figure 2 showed the distribution of the highest educational levels of teachers in Global Impact Stem Academy. The number of teachers that had the BS degree as their highest degree was less than the number of teachers that had the MS degree as their highest degree, among 9 teachers two of them (33.3%) had bachelor degree and 7 (66.7%) teachers had master degree. Previous studies showed similar findings for teachers’ highest level of education (Koralalage, 2001; Okeafor, 2002; Sikinyi, 2003).

![Figure 2: Level of teacher’s education](image)

Demographic information indicates that teachers who participated in this study worked in several fields including animal science (11%), biology (11%), mathematic (22%) and Spanish and other languages (22%). The average years of job as a teacher in Global Impact STEM Academy was 2.5 years. It means most teachers are new and they can
practice sustainable agriculture through in-service training since they believed that knowing about sustainable agriculture is substantially more than capital investment.

Objective 1: Beliefs about Sustainable Agriculture

Descriptive data analysis on teachers’ beliefs in Global Impact Stem Academy indicated that sustainable agriculture was conducted. Results are reported in mean scores, percentages, medians, and standard deviations for the individual items. Table 1 presents a summary of the results. The number of high school teachers who completed data was 9. The overall mean score for teachers’ belief about sustainable agriculture was 3.66. The median score was 3.68 and the mode was 3.65. The standard deviation was .43. Because all the measures of central tendency include meaning, median and mode was almost equal in size, so the curve was relatively normally distributed (Ary et al., 2002).

Items agreed upon most by teachers about sustainable agriculture were: conserves natural resources for the benefit of future generations (mean= 4.8), development of healthy soils is important for sustainable agriculture (mean= 4.4), exchange of knowledge about locally designed technologies among producers promotes sustainable agricultural practices (mean=4.4) and sustainable agriculture promotes recycling of renewable natural resources (mean=4.4). In addition, items with less agreement by the teachers for sustainable agriculture were that sustainable agriculture increases returns to farm labor (mean=2.4), sustainable agriculture values nature for its own sake (mean=2.0), and sustainable agriculture indicates low farm capital investment and technology (mean=1.8).

This study revealed that teachers in GISA believed that sustainable agriculture encourages local processing of agricultural production (Table 1). A
participant commented that sustainable agriculture could have the effect on local growth and increase incomes through producing local foods. When asked about the main reason of ignoring sustainable agriculture by farmers, one teacher mentioned to the lack of teachers’ information about sustainable agriculture more than farmers’ motivation. Participants slightly favored the perceptions that recommended sustainable agricultural practices were not new and only required sustainable agriculture to boost profits and preserve the environment. In addition, the teachers stated that it would require too many people to work if agriculture did away with all the chemicals and cut down on mechanical equipment that uses a lot of fuel.

For the following items, teachers agreed or were neutral that local farming practice success of sustainable agriculture (mean=3.9), sustainable agriculture reduces need for over reliance on external sources of inputs (mean=3.9), integrating diverse crops with livestock enterprises promotes sustainable agriculture, sustainable agriculture practices emphasize rural landscape, and the size of a community impacts development of sustainable agriculture (mean=3.8), Refer to Table 1.
Table 1. General beliefs of teachers toward sustainable agriculture

<table>
<thead>
<tr>
<th>Sustainable agriculture belief statement</th>
<th>Ec/Ev/Sp</th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable agriculture conserves natural resources for the benefit of future generations</td>
<td>So</td>
<td>9</td>
<td>4.8</td>
<td>0.4</td>
</tr>
<tr>
<td>Agricultural knowledge from extension is important for the success of sustainable agriculture</td>
<td>Ec</td>
<td>9</td>
<td>4.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Development of healthy soils is important for sustainable agriculture</td>
<td>Ev</td>
<td>9</td>
<td>4.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Exchange of knowledge about locally designed technologies among producers promotes sustainable agricultural practices</td>
<td>So</td>
<td>9</td>
<td>4.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Sustainable agriculture promotes recycling of renewable natural resources</td>
<td>Ev</td>
<td>9</td>
<td>4.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Sustainable agriculture promotes local marketing of agricultural production</td>
<td>Ec</td>
<td>9</td>
<td>4.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Sustainable agriculture promotes local processing of agricultural production</td>
<td>Ec</td>
<td>9</td>
<td>4.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Local knowledge of farming in a community is an indication</td>
<td>Ev/So</td>
<td>9</td>
<td>4.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Sustainable agriculture promotes specialized crop and livestock enterprise</td>
<td>Ec</td>
<td>9</td>
<td>4.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Local farming practice success of sustainable agriculture</td>
<td>Ec</td>
<td>9</td>
<td>3.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Sustainable agriculture reduces need for over reliance on external sources of inputs</td>
<td>E</td>
<td>9</td>
<td>3.9</td>
<td>1.0</td>
</tr>
<tr>
<td>Integrating diverse crops with livestock enterprises promotes sustainable agriculture</td>
<td>Ev/so</td>
<td>9</td>
<td>3.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Sustainable agriculture practices emphasize rural landscape</td>
<td>So</td>
<td>9</td>
<td>3.8</td>
<td>1.1</td>
</tr>
<tr>
<td>The size of a community impacts development of sustainable agriculture</td>
<td>Ec</td>
<td>9</td>
<td>3.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Innovations in agricultural technology determine the success of sustainable agriculture</td>
<td>Ec</td>
<td>9</td>
<td>3.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Farm size is related to the farm management</td>
<td>E</td>
<td>9</td>
<td>3.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Crop rotation is important to achieving sustainable agriculture</td>
<td>Ev</td>
<td>9</td>
<td>2.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Sustainable agriculture increases returns to farm labor</td>
<td>E</td>
<td>9</td>
<td>2.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Sustainable agriculture values nature for its own sake</td>
<td>So</td>
<td>9</td>
<td>2.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Sustainable agriculture indicates low farm capital investment and technology</td>
<td>Ec</td>
<td>9</td>
<td>1.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Note: *Ec=economic or Ev=environment or So= social dimension of sustainable agriculture;

1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree; n=umber completing questionnaire; SD = standard deviation

In Table 2 percents of teachers’ responses about their sustainable agriculture beliefs are shown. Teachers agreed with most of the items, except items of sustainable agriculture values nature for its own sake, sustainable agriculture indicates low farm capital investment/technology and crop rotation is important to achieving sustainable agriculture.
The teachers had a percentage of at least 50% agree or strongly agreed with sustainable agriculture for the following items: sustainable agriculture promotes local marketing of agricultural production, sustainable agriculture conserves natural resources for the benefit of future generations, local farming practice success of sustainable agriculture. Additionally, teachers agreed with rural landscape, farm size is related to the farm management, innovations in agricultural technology determine the success of sustainable agriculture, sustainable agriculture promotes recycling of renewable natural resources, local knowledge of farming in a exchange of knowledge, and locally designed technologies among producers promotes sustainable agricultural practices community. Furthermore, the teachers highlighted the size of a community impacts development of sustainable agriculture, sustainable agriculture reduces need for over reliance on external sources of inputs, development of healthy soils is important for sustainable agriculture, and sustainable agriculture reduces need for over reliance on external sources of inputs. Refer to Table 2 for all percent values.
Table 2. Relative frequencies of individual items on beliefs about sustainable agriculture

<table>
<thead>
<tr>
<th>Sustainable agriculture belief statement</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable agriculture promotes local marketing of agricultural production</td>
<td>0 0 22.2 55.6 22.2</td>
</tr>
<tr>
<td>Sustainable agriculture conserves natural resources for the benefit of future generations</td>
<td>0 0 22.2 77.8</td>
</tr>
<tr>
<td>Local farming practice success of sustainable agriculture</td>
<td>0 22.2 11.1 22.2 44.4</td>
</tr>
<tr>
<td>Sustainable agriculture practices emphasize rural landscape</td>
<td>0 11.1 33.3 22.2 33.3</td>
</tr>
<tr>
<td>Farm size is related to the farm management</td>
<td>11.1 11.1 22.2 33.3 22.2</td>
</tr>
<tr>
<td>Sustainable agriculture values nature for its own sake</td>
<td>44.4 22.2 22.2 11.1 0</td>
</tr>
<tr>
<td>Sustainable agriculture promotes recycling of renewable natural resources</td>
<td>0 0 11.1 33.3 55.6</td>
</tr>
<tr>
<td>Innovations in agricultural technology determine the success of sustainable agriculture</td>
<td>0 11.1 33.3 33.3 22.2</td>
</tr>
<tr>
<td>Sustainable agriculture indicates low farm capital investment and technology</td>
<td>44.4 33.3 22.2 0 0</td>
</tr>
<tr>
<td>Sustainable agriculture promotes local processing of agricultural production</td>
<td>0 0 22.2 44.4 33.3</td>
</tr>
<tr>
<td>Agricultural knowledge from extension is important for the success of sustainable agriculture</td>
<td>0 0 11.1 33.3 55.6</td>
</tr>
<tr>
<td>Crop rotation is important to achieving sustainable agriculture</td>
<td>33.3 22.2 11.1 33.3 0</td>
</tr>
<tr>
<td>Local knowledge of farming in a community is an indication</td>
<td>0 0 33.3 33.3 33.3</td>
</tr>
<tr>
<td>Exchange of knowledge about locally designed technologies among producers promotes sustainable agricultural practices</td>
<td>0 0 0 55.6 44.4</td>
</tr>
<tr>
<td>Integrating diverse crops with livestock enterprises promotes sustainable agriculture</td>
<td>0 11.1 33.3 22.2 33.3</td>
</tr>
<tr>
<td>Sustainable agriculture promotes specialized crop and livestock enterprise</td>
<td>0 0 33.3 33.3 33.3</td>
</tr>
<tr>
<td>The size of a community impacts development of sustainable agriculture</td>
<td>0 11.1 22.2 44.4 22.2</td>
</tr>
<tr>
<td>Sustainable agriculture reduces need for over reliance on external sources of inputs</td>
<td>0 11.1 22.2 33.3 33.3</td>
</tr>
<tr>
<td>Sustainable agriculture increases returns to farm labor</td>
<td>22.2 22.2 44.4 11.1 0.0</td>
</tr>
<tr>
<td>Development of healthy soils is important for sustainable agriculture</td>
<td>0 0 11.1 33.3 55.6</td>
</tr>
</tbody>
</table>

Note: 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree

Objective 2: Perceptions of Agricultural Practices

Descriptive data analysis on teachers’ perceptions from GISA toward selected agricultural practices was reported in means, medians and standard deviation, and percentages for individual items.

Results of teacher perceptions regarding sustainable agriculture practices were soil test (mean=4.3), use of green manure (mean=4.1), conservation tillage (mean=4.0), integrate pest management (mean=4.0), mechanical weeding (mean=4.0), reduced rates of herbicide (mean=4.0), reduced tillage (mean=4.0), use of animal manure (mean=4.0)
as the top agreed upon items for sustainable agriculture practices. The lowest mean scores for sustainable agriculture practices were recycling agriculture waste (mean=3.3), reduced nitrogen fertilizer rates (mean=3.3), reduced use of fertilizer (mean=3.3), rotational grazing (mean=3.3), and insect resilience crops (mean=3.2). See Table 3.

Table 3. Frequencies, means and standard deviations for individual items on perceptions of teachers regarding sustainable agriculture practices

<table>
<thead>
<tr>
<th>Perceptions of teachers regarding sustainable agriculture practices</th>
<th>n</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil test</td>
<td>9</td>
<td>4.33</td>
<td>0.71</td>
</tr>
<tr>
<td>Use of green manure</td>
<td>9</td>
<td>4.11</td>
<td>0.93</td>
</tr>
<tr>
<td>Conservation tillage</td>
<td>9</td>
<td>4.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Integrate pest management</td>
<td>9</td>
<td>4.00</td>
<td>0.87</td>
</tr>
<tr>
<td>Mechanical weeding</td>
<td>9</td>
<td>4.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Reduced rates of herbicide</td>
<td>9</td>
<td>4.00</td>
<td>1.41</td>
</tr>
<tr>
<td>Reduced tillage</td>
<td>9</td>
<td>4.00</td>
<td>1.41</td>
</tr>
<tr>
<td>Use of animal manure</td>
<td>9</td>
<td>4.00</td>
<td>1.11</td>
</tr>
<tr>
<td>Fall seeded cover crop</td>
<td>9</td>
<td>3.9</td>
<td>0.93</td>
</tr>
<tr>
<td>Crop rotation</td>
<td>9</td>
<td>3.9</td>
<td>1.19</td>
</tr>
<tr>
<td>Narrow strip intercropping</td>
<td>9</td>
<td>3.56</td>
<td>0.88</td>
</tr>
<tr>
<td>Low input livestock facilities</td>
<td>9</td>
<td>3.56</td>
<td>0.73</td>
</tr>
<tr>
<td>Herbicide resistance crops</td>
<td>9</td>
<td>3.44</td>
<td>0.73</td>
</tr>
<tr>
<td>Use of nitrification inhibitor</td>
<td>9</td>
<td>3.44</td>
<td>1.42</td>
</tr>
<tr>
<td>Nitrogen application</td>
<td>9</td>
<td>3.44</td>
<td>0.73</td>
</tr>
<tr>
<td>Row banding of herbicides</td>
<td>9</td>
<td>3.44</td>
<td>0.88</td>
</tr>
<tr>
<td>Recycling agriculture waste</td>
<td>9</td>
<td>3.33</td>
<td>1.66</td>
</tr>
<tr>
<td>Reduced nitrogen fertilizer rates</td>
<td>9</td>
<td>3.33</td>
<td>1.35</td>
</tr>
<tr>
<td>Reduced use of fertilizer</td>
<td>9</td>
<td>3.33</td>
<td>1.32</td>
</tr>
<tr>
<td>Rotational grazing</td>
<td>9</td>
<td>3.33</td>
<td>1.66</td>
</tr>
<tr>
<td>Insect resilience crops</td>
<td>9</td>
<td>3.22</td>
<td>0.83</td>
</tr>
</tbody>
</table>

1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree;

The teachers had a combined percentage of at least 50% on strongly agree and agree values for these items including crop rotation, soil test, conservation tillage,
integrate pest management, rotational grazing, recycling agriculture waste, use of green manure, and reduced rates of herbicide. In addition, the teachers agreed or strongly agreed with reduced use of fertilizer, fall seeded cover crop, use of nitrification inhibitor, nitrogen application, and necessary for attainment of a sustainable agriculture. Further, the teachers highlighted the role of information with their answers including exchange of knowledge about locally designed technologies among producers and agricultural knowledge from extension is important for the success of sustainable agriculture. Additionally, they agreed with promotes sustainable agricultural practices, development of healthy soils is important for sustainable agriculture, innovations in agricultural technology determine the success of sustainable agriculture, sustainable agriculture indicates low farm capital investment and technology, and sustainable agriculture promotes local processing of agricultural production.

Items with disagree for sustainable agriculture practices were recycling agriculture waste, integrate pest management, recycling agriculture waste, and use of low input livestock facilities. See Table 4.
Objective 3: Sustainable Agriculture Concepts for Teaching

Teachers’ perceptions about sustainable agriculture concepts that they taught were another objective of this study. Table 5 presents a summary of the findings. Generally, mean scores were taught to a moderate extent about sustainable agriculture (M= 3.37...
High school teachers in Global Impact STEM Academy taught sustainable agriculture concepts with different proportions with highest mean values for renewable sources of energy (Mean=4), wildlife conservation (Mean=3.8), protection of wetlands, recycling agriculture waste, (Mean=3.7), narrow strip intercropping, nitrogen allocation, rotational grazing, food safety (Mean =3.6). Items with the lowest means values for teaching sustainable agriculture topics were green manure, integrated pest management, use of low input livestock facilities, mechanical weeding, soil test (Mean=3.1), fall seeded cover crops (Mean=3), and animal manure (Mean=2.8). See Table 5.

Table 5. Mean, standard deviation of sustainable agriculture concepts taught

<table>
<thead>
<tr>
<th>Topics</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable sources of energy</td>
<td>9</td>
<td>4.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Wildlife conservation</td>
<td>9</td>
<td>3.8</td>
<td>1.3</td>
</tr>
<tr>
<td>Protection of wet lands</td>
<td>9</td>
<td>3.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Recycling agriculture waste</td>
<td>9</td>
<td>3.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Narrow strip intercropping</td>
<td>9</td>
<td>3.6</td>
<td>1.3</td>
</tr>
<tr>
<td>Nitrogen allocation</td>
<td>9</td>
<td>3.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Rotational grazing</td>
<td>9</td>
<td>3.6</td>
<td>1.3</td>
</tr>
<tr>
<td>Food safety</td>
<td>9</td>
<td>3.5</td>
<td>0.8</td>
</tr>
<tr>
<td>Herbicide resistant crops</td>
<td>9</td>
<td>3.4</td>
<td>0.7</td>
</tr>
<tr>
<td>Reduce nitrogen fertilizer</td>
<td>9</td>
<td>3.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Air pollution</td>
<td>9</td>
<td>3.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Crop rotation</td>
<td>9</td>
<td>3.3</td>
<td>0.7</td>
</tr>
<tr>
<td>Use of nitrification</td>
<td>9</td>
<td>3.3</td>
<td>0.9</td>
</tr>
<tr>
<td>Water quality</td>
<td>9</td>
<td>3.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Insect resistant crops</td>
<td>9</td>
<td>3.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Reduce tillage</td>
<td>9</td>
<td>3.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Reduced rates of herbicides</td>
<td>9</td>
<td>3.2</td>
<td>0.7</td>
</tr>
<tr>
<td>Row banding of herbicides</td>
<td>9</td>
<td>3.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Green manure</td>
<td>9</td>
<td>3.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Integrated pest management</td>
<td>9</td>
<td>3.1</td>
<td>0.7</td>
</tr>
<tr>
<td>Mechanical weeding</td>
<td>9</td>
<td>3.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Soil test</td>
<td>9</td>
<td>3.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Use of low input livestock facilities</td>
<td>9</td>
<td>3.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Fall seeded cover crops</td>
<td>9</td>
<td>3.0</td>
<td>0.7</td>
</tr>
<tr>
<td>Animal manure</td>
<td>9</td>
<td>2.8</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Note: 1 = None; 2 = Low Extent; 3 = Moderate Extent; 4 = High Extent; 5 = Very High Extent: SD = Standard deviation
Items with percent values for agriculture concepts taught of at least 50% for high and very extent were recycling agriculture waste, protection of wetlands, wildlife conservation, renewable sources of energy, and narrow strip intercropping. Items with the lowest percent values were fall-seeded cover crops, use of low input livestock facilities, and integrated pest management (See Table 6).

Table 6. Percent values for sustainable agriculture concepts taught.

<table>
<thead>
<tr>
<th>Sustainable agriculture for teaching</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water quality</td>
<td>11.1</td>
<td>0</td>
<td>44.4</td>
<td>33.3</td>
<td>11.1</td>
</tr>
<tr>
<td>Recycling agriculture waste</td>
<td>0</td>
<td>11.1</td>
<td>33.3</td>
<td>33.3</td>
<td>22.2</td>
</tr>
<tr>
<td>Food safety (n = 8)</td>
<td>0</td>
<td>0</td>
<td>62.5</td>
<td>25.0</td>
<td>12.5</td>
</tr>
<tr>
<td>Protection of wet lands</td>
<td>0</td>
<td>0</td>
<td>33.3</td>
<td>55.6</td>
<td>11.1</td>
</tr>
<tr>
<td>Renewable sources of energy</td>
<td>0</td>
<td>0</td>
<td>33.3</td>
<td>33.3</td>
<td>33.3</td>
</tr>
<tr>
<td>Wildlife conservation</td>
<td>11.1</td>
<td>0</td>
<td>22.2</td>
<td>33.3</td>
<td>33.3</td>
</tr>
<tr>
<td>Air pollution</td>
<td>11.1</td>
<td>0</td>
<td>44.4</td>
<td>22.2</td>
<td>22.2</td>
</tr>
<tr>
<td>Rotational grazing</td>
<td>11.1</td>
<td>0</td>
<td>44.4</td>
<td>11.1</td>
<td>33.3</td>
</tr>
<tr>
<td>Narrow strip intercropping</td>
<td>11.1</td>
<td>0</td>
<td>33.3</td>
<td>33.3</td>
<td>22.2</td>
</tr>
<tr>
<td>Fall seeded cover crops</td>
<td>0</td>
<td>22.2</td>
<td>55.6</td>
<td>22.2</td>
<td>0</td>
</tr>
<tr>
<td>Use of low input livestock facilities</td>
<td>0</td>
<td>22.2</td>
<td>55.6</td>
<td>11.1</td>
<td>11.1</td>
</tr>
<tr>
<td>Row banding of herbicides</td>
<td>0</td>
<td>11.1</td>
<td>66.7</td>
<td>11.1</td>
<td>11.1</td>
</tr>
<tr>
<td>Integrated pest management</td>
<td>0</td>
<td>22.2</td>
<td>55.6</td>
<td>11.1</td>
<td>11.1</td>
</tr>
<tr>
<td>Soil test</td>
<td>0</td>
<td>11.1</td>
<td>77.8</td>
<td>11.1</td>
<td>11.1</td>
</tr>
<tr>
<td>Nitrogen allocation</td>
<td>0</td>
<td>0</td>
<td>66.7</td>
<td>11.1</td>
<td>22.2</td>
</tr>
<tr>
<td>Insect resistant crops</td>
<td>0</td>
<td>11.1</td>
<td>66.7</td>
<td>11.1</td>
<td>11.1</td>
</tr>
<tr>
<td>Mechanical weeding</td>
<td>0</td>
<td>11.1</td>
<td>77.8</td>
<td>0</td>
<td>11.1</td>
</tr>
<tr>
<td>Reduced rates of herbicides</td>
<td>0</td>
<td>0</td>
<td>88.9</td>
<td>0.0</td>
<td>11.1</td>
</tr>
<tr>
<td>Reduce nitrogen fertilizer</td>
<td>0</td>
<td>11.1</td>
<td>55.6</td>
<td>11.1</td>
<td>22.2</td>
</tr>
<tr>
<td>Use of nitrification</td>
<td>0</td>
<td>11.1</td>
<td>55.6</td>
<td>22.2</td>
<td>11.1</td>
</tr>
<tr>
<td>Reduce tillage</td>
<td>0</td>
<td>0</td>
<td>88.9</td>
<td>0</td>
<td>11.1</td>
</tr>
<tr>
<td>Green manure</td>
<td>0</td>
<td>11.1</td>
<td>77.8</td>
<td>0</td>
<td>11.1</td>
</tr>
<tr>
<td>Herbicide resistant crops</td>
<td>0</td>
<td>0</td>
<td>66.7</td>
<td>22.2</td>
<td>11.1</td>
</tr>
<tr>
<td>Crop rotation</td>
<td>0</td>
<td>0</td>
<td>77.8</td>
<td>11.1</td>
<td>11.1</td>
</tr>
<tr>
<td>Animal manure</td>
<td>11.1</td>
<td>0</td>
<td>88.9</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: 1=None; 2=Low Extent; 3=Moderate; 4=High Extent; 5=Very High Extent; n = 9
Objective 4: Teaching Methods Utilized

The total mean score for this section was 4.0 (SD = 0.86) and teachers used different teaching methods to transfer sustainable agriculture to students. The results show that the most respondents had scores close to the average score (Ary et al., 2002; McMillan & Schumacher, 2001). Methods used most by teachers were group discussion, hands-on-learning, projects, websites, videotapes, and demonstrations. Methods used least were reading assignment, lecture, and one-on-one instruction. Refer to Table 7.

Table 7. Mean and standard deviations for methods used to teach sustainable agriculture

<table>
<thead>
<tr>
<th>Teaching methods and tools</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group discussion</td>
<td>9</td>
<td>4.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Hands-on-learning</td>
<td>9</td>
<td>4.0</td>
<td>0.9</td>
</tr>
<tr>
<td>Projects</td>
<td>9</td>
<td>4.0</td>
<td>0.7</td>
</tr>
<tr>
<td>Website</td>
<td>9</td>
<td>3.9</td>
<td>0.7</td>
</tr>
<tr>
<td>Video taps</td>
<td>9</td>
<td>3.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Demonstration</td>
<td>9</td>
<td>3.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Case study</td>
<td>9</td>
<td>3.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Workshop</td>
<td>9</td>
<td>3.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Field days</td>
<td>9</td>
<td>3.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Debates</td>
<td>9</td>
<td>3.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Reading assignment</td>
<td>9</td>
<td>3.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Lecture</td>
<td>9</td>
<td>3.0</td>
<td>0.9</td>
</tr>
<tr>
<td>One-on-one instruction</td>
<td>9</td>
<td>3.0</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Note: 1 = none; 2 = low extent; 3 = moderate extent; 4 = high extent; 5 = very high extent;

Top-ranked items by percent value (more than 60%) were group discussion, projects, website, videotapes, debates, demonstrations, case study, and field days. Least used teaching methods for sustainable agriculture according to percent values were lecture, one-on-one instruction, and field days. Teaching methods were used by teachers indicate that they used more group methods such as group discussion. Also they utilized
some tools to transfer some information about sustainable agriculture such as videotapes, and website (See Table 8).

Table 8. Percentages for methods used to teach sustainable agriculture

<table>
<thead>
<tr>
<th>Teaching methods and tools</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group discussion</td>
<td>0</td>
<td>0</td>
<td>22.2</td>
<td>44.4</td>
<td>33.3</td>
</tr>
<tr>
<td>Hand-on- learning</td>
<td>0</td>
<td>0</td>
<td>33.3</td>
<td>33.3</td>
<td>33.3</td>
</tr>
<tr>
<td>Projects</td>
<td>0</td>
<td>0</td>
<td>22.2</td>
<td>55.6</td>
<td>22.2</td>
</tr>
<tr>
<td>Website</td>
<td>0</td>
<td>11.1</td>
<td>33.3</td>
<td>44.4</td>
<td>22.2</td>
</tr>
<tr>
<td>Videotapes</td>
<td>0</td>
<td>11.1</td>
<td>22.2</td>
<td>44.4</td>
<td>22.2</td>
</tr>
<tr>
<td>Demonstration</td>
<td>0</td>
<td>0</td>
<td>33.3</td>
<td>55.6</td>
<td>11.1</td>
</tr>
<tr>
<td>Case study</td>
<td>0</td>
<td>11.1</td>
<td>11.1</td>
<td>77.8</td>
<td>0</td>
</tr>
<tr>
<td>Workshop</td>
<td>0</td>
<td>0</td>
<td>44.4</td>
<td>44.4</td>
<td>11.1</td>
</tr>
<tr>
<td>Field days</td>
<td>0</td>
<td>11.1</td>
<td>22.2</td>
<td>55.6</td>
<td>11.1</td>
</tr>
<tr>
<td>Debates</td>
<td>0</td>
<td>11.1</td>
<td>33.3</td>
<td>44.4</td>
<td>11.1</td>
</tr>
<tr>
<td>Reading assignment</td>
<td>11.1</td>
<td>11.1</td>
<td>22.2</td>
<td>55.6</td>
<td>0</td>
</tr>
<tr>
<td>Lecture</td>
<td>0</td>
<td>33.3</td>
<td>33.3</td>
<td>33.3</td>
<td>0</td>
</tr>
<tr>
<td>One- on one instruction</td>
<td>0</td>
<td>22.2</td>
<td>55.6</td>
<td>22.2</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: 1 = none; 2 = low extent; 3 = moderate extent; 4 = high extent; 5 = very high extent.

Findings: Qualitative

Observation

Study findings were organized around several themes that were drawn from the classroom observation.

Theme: Experiential learning opportunities allowed participants to apply knowledge in a real-world context.

Teachers taught some topics, that had connections with students’ lives, and they consistently emphasized the program’s experiential learning opportunities and
encouraged participants to apply knowledge in the real-world. The researchers observed different educational methods such as group discussion, lecture, and peer mentoring.

To further accomplish conceptual realistic applications and knowledge, students were expected to utilize the information presented throughout the curriculum. One way that the Academy sought to accomplish this goal was through semester-long projects. The teacher had an assignment for the students in which they had to design a hydroponic project with small and disposable containers. Students were assigned a subset of urban farming hydroponics. Although the school prepared some disposable containers for them, students were allowed to use their own small and disposable container. In addition, the teacher discussed numerous personal and professional experiences about certain food. She made connections between their daily lives, particularly some changes in their food and different chemical reactions, so students could understand academic concepts in a practical way. There experimental learning opportunities allowed participants to apply knowledge in real life.

In other parts of the curriculum, participants expressed similar motivation as a result of the program, and they desired to continue learning. Particularly, the teacher emphasized a sustainable environment. The lab containers were recycled and usually they tried to avoid chemical substances. Therefore, students learned that they should protect their environment in their future job so they designed projects with the goal of protecting the environment. The teacher highlighted the student-centered nature of the program.

One significant facet in this curriculum was student-centered and the teachers considered students’ educational requirements while also attempting to teach something in which the students were interested.
Participants consistently felt that teachers made a conscious effort to understand their needs and to provide beneficial experiences. Several participants commented that every aspect of the program, even simple things like developing work schedules, were student-centered and allowed participants to make the experience work as best as it could for them.

Theme: Ongoing research projects provided additional experiential opportunities for program participants.

The program provided research opportunities to collaborate with students and to prepare another opportunity for practical knowledge. Teachers explained that The Ohio State University prepared some plants and lab equipment for them to conduct research, although research was not initially a program priority. Research steadily became more important, as it provided additional opportunities for individualized attention while promoting the growth of professional skills. Furthermore, these kinds of academic resources paralleled critical thinking, problem solving, and using research as a method to teach some of those concepts while preparing the students to understand the environmental microbiology. At the same time, the teachers tried to simplify complicated concepts and new topics by providing relevance to students.

Theme: Relationships among teachers, students, and peer group influenced participant experiences in an immersive environment.

Generally, teachers were creating a collaborative atmosphere among students. For instance, a group of students who learned this new subject several days ago visited
current classes to assist other students who were ready to learn practical experience from their class and a new subject. In this case, the teachers utilized peer mentoring as an educational method. This science class was a practical class in the lab and after a short lecture, students were encouraged to apply it in several groups and to apply the new information in real experiences. Experiential views of the programmatic design provided interrelation skills among participants.

Theme: Programmatic design incorporated community involvement and consequently provided valuable networking opportunities for participating students.

This school has a strong connection with parents and the local community. Parents can monitor their children’s activities in their school via their account on the school website. Additionally, the local community has connections with the school, and they are supporting the school financially so, relationships among parents, the local community, and Global Impact STEM Academy staff penetrated participant experiences in an immersive atmosphere. Therefore, the programmatic model integrates community involvement and consequently provided valuable networking opportunities for participating students.

Theme: Experiential aspects of programmatic design fostered personal growth in participants.

Personal growth was a theme that quickly emerged from the observations. The program’s student-centered nature and experiential environment fostered teamwork and leadership in participants. The teachers consistently discussed the need to prepare hands-
on experiences and in-depth classes for students. The lab was very immersive for students and very individualized, because teachers did not compare students with each other; the baseline for teachers was students’ capability in a topic, not the goals of a predesigned curriculum. The benchmark to evaluate students was their level of learning. Program resources provided teachers with support for a student-centered learning environment. The environment helped to foster students’ leadership skills and time management.

Focus Group Interview Data

The following qualitative results are presented according to the schedule of focus group questions and focus group analysis generating common themes (Krueger & Casey, 2000).

Question #1
Q: Why do you think we are engaging you in a conversation about integrating sustainable agriculture into your classroom environments?

Theme: Population growth.
P10: … our population growth is, you know, growing until 9 billion by 2050, so it’s something that we really need to look at if we want to have room for agriculture and for the population growth itself.

Theme: Future generations understanding impact
P10: … And as an educator, it’s one of the things I really focus on is making sure the future generations understand the impact they are making now and what has been already done. Has already happened.

Theme: Environmental issues and our practices
P18: Also with all the environmental issues especially with the different..like the clean water act and the different bills, the manure application that they are looking at, to start those conversations with not just amongst farmers but also consumers by attending the commodity classic a couple years ago, and talking to farmers as a city person, and then coming and teaching in a school that is an ag/bioscience based stem school, what are they doing and looking at? What is affecting our water quality? You know, you can’t put it all back on the farmer and what practices are they doing that are sustainable for their area, and just look at what else.. How are we as consumers can be part of that decision.
P14: We all are a part of clean water, clean air, good food.

Theme: Climate change
P15: Maybe part of it is some people still don’t think climate change is real so maybe having a conversation about sustainability in agriculture would convince people who may not believe that the climate is even changing

Theme: Educating and promoting changed behaviors
P16: I think if we are going to promote change we must first assess our own definitions of what that means before we can appropriately educate our young people to make that change. We have to know what it means to us.
P16: Well it raises a question in my mind that I think of all the time of how do we educate our students to get them to care enough to change their daily habits because they know what the problem is or they should know or we might try to teach them what the problem is. But how do we get them to care to change their daily habits to be stewards of the earth and the same for us as adults too.

Theme: Technological and research advances
P18: Technology has changed and not always means that it’s a positive thing, sometimes some of the traditional ways could be just as effective or are they as effective some of the new technology and what… Especially when you go and you’re working with developing countries, would it be best for their practices in other countries vs. ours? Then start looking at some other ways to incorporate.
Unknown person: When I first thought of my answer I was hoping that maybe there is somebody doing research on how we can better educate students on what sustainable agriculture means and so I am hoping that there is some background research on what teachers believe it is and then so like the starting point and then where we need to go from there. I guess that is what I was trying to say earlier.

Theme: Consumer choices
P12: And so when we talk about the consumer, or most of the consumers going out there, I mean businesses- they’re not going to want to change unless the consumer market changes like as far organic is getting more popular and gluten free is getting more popular but that’s consumer driven because the consumers want that. So it may be... One of the questions you hear is like they want research to see are we educating the students in these things and if we are at this school, what schools aren’t doing that?
P18: And cost, will consumers pay for it?
P13: Man, That article about Whole Foods had to like reduced their prices which is going to affect the quality of the food they are producing because no one is willing to pay that high of prices anymore whatever, that was very interesting actually…
P18: And transportation of the food.
[Other Interjecting]: It’s consumer driven.
P13: …While Kroger and Walmart like cutting corners and are selling the same thing for cheaper, Whole Foods Asparagus water is going through the roof.

Question #2
Q: Why do you think we are engaging you in a conversation about integrating sustainable agriculture into your classroom environments?

*Theme: Educating young minds*

P20: Because we are supposed to educate the young minds of our community. It starts with the first line of defense. And then they can educate their family and it can just go further and further.

*Theme: Philosophy of working at an agriculture-based school and the content being taught*

P17: Specifically us though probably because we are an agriculturally based school.

P14: It goes with the theme of what we are to be addressing

P18: … I guess is the best way or at least CTE background - Career Technical Education in ag bioscience. So they are having classes on plant and animal biotechnology, bioresearch, science and technology of foods. So at least in their areas and then we’re trying to incorporate that across the board in all of our classes and it’s still a work in progress, even in sciences. So we are trying to develop projects and that why we are adding a greenhouse, so we can play around with different agricultural techniques and bring in other businesses. Its why we have them do the World Food Prize paper and introduce them to Norman Borlaug in food science class. Through those projects.

*Theme: Engaging students through application of science content*

P14: I think also it’s a way that we can engage students in something that they should care about and they can apply topics too that they ordinarily don’t think about. Like they can apply chemistry or they can apply physical science to air and water and hopefully to the extent that they understand the key areas within education that are typically thought of as being taught in a classroom but apply it to something that is more applicable and something they can put their hands on and something where they can make a difference.

*Theme: Engaging students through application of social content*

P18: Well and if nothing else at least they’re speaking, at least in government and American history bringing their… Up to speed of what is going on and the current issues and why political groups think different ways and how to try to help in that problem solving.

P15: Sure and I think capitalism affects that.

*Theme: Engaging students through implementation of projects*

P12: Also your Zero waste initiative, there’s been kids already coming to us asking what about this, what about this, and it’s like they are looking at the policies and the law, the
logistics and like one of the students there is like budgeting out... You know he is doing the math for how do we save money changing these practices from like Styrofoam trays to plastic washable trays. And so it’s easily all encompassing, it involves...I mean it involves... I mean it doesn’t just have to be like the Chemistry of it you know. There is a lot of aspects you know that go on beyond it you know like law making, people groups involved, and the cultures. You know how they have always done things, changing those habits or maybe reinforcing those habits it’s definitely something that we... that not all the time but always try to implement quite a bit into our curriculum.

Theme: Willingness to try new things
[Unknown Person] We are also a school that tries different things, so we aren’t afraid to try different projects and different ideas so maybe there is projects that you would like us to implement maybe. That we wouldn’t be afraid to try.

Theme: Partnering with business
P18: Part of the business partnership.

Theme: Teaching to meet ODE and CTE standards, but through application
P12: No but is it something that is going to become like standards you know for ODE or whatever... not just for CTE stuff but on the state testing and general...

Theme: Role modeling behaviors
P20: ... I don’t know I think it was just something I picked up along the way in teacher school...I mean like we teach the kids and then they learn from us and our actions... So... I mean in most cases, teachers are role models to a lot of the kids. So, what we teach them. I think I just said that.

Question #3
Q: Based on your three definitions (above) describe what you are currently doing, or what this discussion has prompted you to consider doing, to integrate sustainable agriculture concepts into your classroom environments.

Theme: Currently doing: Sustainable project, challenge-based approach
P11: Asking how can we make the school zero waste and then leave it up to the students to working with them mumble to get to that goal.
P15: Field trips around the school to find what our needs are or to see where our biggest areas of waste are so they are all over the place with their ideas from like changing the lunch trays to being reusable lunch trays to.
P14: And bioresearch class and then animal and plant biotechnology is doing hydroponics and then environmental sustainability ..........

Theme: How the topic was chosen
P15: ..... Part of the students have it too so like I know that students have remarked about how much waste they see either in the cafeteria or even... We have a kind of a recycling program right now but it’s not as effective as it could be.....
P18: Like we have a senior that for their capstone is going to take the unused food in the cafeteria once it’s been out they cannot put it back into the service area so they’re going to collect it and actually take it to the homeless shelter in the area……

Theme: Required resources
P15: Information that I’m not aware of. Definitely not my area of expertise at all, so possibly bringing in an expert or finding the right academic journals or sources because we create our own curriculum…..

Theme: Departmental function
P10: … all the teachers have complete autonomy, so if they need to change something, they can. They aren’t tied to any sort of structure. So that helps with scaffolding too…..

Theme: Assessment
Unknown Person]: … we are teaching them multiple ways to learn and to do things so we are more or less helping them to be better problem solvers or deductive thinking or being able to extraculate data so that they can come up with some sort of reasoning behind it….
P10: We are not evaluated through OTES which most high schools… Most schools are in Ohio. So we have our own evaluation protocol through our director and I think he understands our approach and I mean at least when I am evaluated I feel confident in my evaluation.

Theme: Methodology
P10: …there’s a lot less direct instruction via, you know, lecture or that sort of thing. There is a lot more hands on, problem based, project based learning… modeling. In social studies they use Socratic seminar a lot… A lot more student centered rather than the direct approach.
P15: ….. I think my role is more of a facilitator than a teacher……
P14: Working in groups.
P17: Yeah, I was going to say, I like to mix like lecture with some sort of visual and then a lab or some hands-on inquiry based learning.
Theme 7: Consider doing
P15: ….. but if we can continue to encourage other communities to proceed forward with it, we could see it really take off and grow. And I think that would impact students very positively
P17: I’d love to like do water quality testing and all of those things, but one thing I have done, is have them compare and contrast the pros and cons of nuclear energy…

Summary for Focus Group Interview
The research team facilitated a focus group interview with teachers at GISA. They also conducted a classroom observation of a teacher in the sustainable agriculture curriculum. Data were analyzed for common themes. The summary is organized around the themes.

Theme: Program resources allowed administrators to maintain a student-centered learning environment.

The Program planners utilized pre-existing academic resources to build academic foundations that students were receiving at the school. The teachers then transfer new information to students with a student-centered view.

Initially, the research team asked participants about academic terms such as agriculture, and sustainability. For instance, one of the teachers defined agriculture as, “To me, agriculture also includes the natural resources, the environment, you landscaping horticulture concept ideas. I’m a broader person” and another participant included, “I said “the creation of food, materials, goods that are produced through farming.”

The research team proposed the term, which was sustainability. The participants had different projects for their students and they tried to update their information about their projects with academic journals. For example, one of the participants revealed, “Definitely not my area of expertise at all, so possibly bringing in an expert or finding the right academic journals or sources because we create our own curriculum. So I use what I already know or do very little research since I’ve already taught similar stuff, so I just aggregate what I’ve already used in years past or semester past.”
Another participant added, “if I do not have information about a topic, I will ask a
specialist to introduce me a relevant journal to collect more information about it”. When
considering the role of administrator, a participant said, “I think my role is more of a
facilitator than a teacher. So if it is lecture based, it’s just so the kids feel like they
understand I guess the background information, what they are going to be researching, or
what they’re covering, or building.”

Program resources allowed administrators to maintain a student centered learning
environment. An administrator responded to this question, “How can you explain
sustainable agriculture for your students?” they explained, “I would just echo what
they’re saying”. It means student centered is teaching substantial in their classroom.
Participants emphasized student centered programs and they highlighted “… A lot more
student-centered rather than the direct approach.

One important characteristic of a successful teaching process is flexibility with
student centered view, so another participant mentioned, “If they’re not learning it
through a lecture, we have taught the research skills. What’s a primary source and
credible source? With the use of technology at their fingertips; they can hopefully
discover and research that for themselves”.

Theme: Experiential learning opportunities allowed participants to apply knowledge in a
real-world context.

Participants emphasized the program’s experiential learning opportunities, which
led participants to apply knowledge in a real world. Administrators strongly highlighted
training students to apply the knowledge they learned in coursework. Participants
constantly highlighted that the program’s experiential learning opportunities support students to apply knowledge in a real-world situation. Participants strongly focused on training students to apply the knowledge that they were taught in coursework. A participant tried to make connection between sustainable agriculture populations. They highlighted this problem with a serious challenge because students will not forget about the necessity of solving this problem and added, “this concept has connection with everybody because of a growing population and we should save our natural resources for new generation and they explained, “Instead of blaming someone, our population growth is, you know, growing until 9 billion by 2050, so it’s something that we really need to look at if we want to have room for agriculture and for the population growth itself.” This answer indicated that administrators were considering ‘experiential learning’ opportunities, and they allowed participants to apply knowledge in a real-world context. Another administrator explained that to achieve sustainability I encourage my students to reuse and recycle materials to lower environmental impact while producing or maintaining needs.

The teachers considered that applying information in the real circumstances by students is their goal. One of them expressed that, “I think it’s also a way that we can engage students in something that they should care about and they can apply topics too that they ordinarily don’t think about, and another interviewee exemplified, “Like they can apply chemistry or they can apply physical science to air and water and hopefully to the extent that they understand the key areas within education that are typically thought of as being taught in a classroom, but apply it to something that is more applicable and
something they can put their hands on and something where they can make a difference.”

Another participant demonstrated applying concepts in the class:

“Basically just asking how can we make the school zero waste and then leave it up to the students to working with them. So like a challenge based approach. Literally some of them took field trips around the school to find what our needs are or to see where our biggest areas of waste are so they are all over the place with their ideas from like changing the lunch trays to being reusable lunch trays to…”

Additionally, a participant highlighted two projects, which were hydroponics and paperless schools and stated, “Measuring how much paper we are using per month to then aggregate data to see if we are able to change it and how much we are cutting back on.”

An administrator illustrated making experiential learning opportunities for students to apply new knowledge in their life and pointed out, “Various science classes are kind of taking different aspects of calling it urban farming but we are doing like aquaponics is one component. And bioresearch class and then animal and plant biotechnology is doing hydroponics and then environmental sustainability is doing like eco columns make sure that both of the terrestrial and the aquaculture and kind of we are going to compare data and see if this data...”.

Administrators strongly emphasized training students to apply the knowledge that they taught in coursework and declared, “the topics they’re selecting are purposeful topics, they are not willy-nilly topics. They are picked for a reason. They are authentic
topics. We bring outside people in and the teachers relate the projects that they do to content that the kids need to learn (other injects agreement).”

Theme: Ongoing research projects provided additional experiential opportunities for program participants.

The program also provides research opportunities for students, to participate in applied knowledge project. A participant mentioned that,

“Still a work in progress. I think in some areas a little more. One thing the students their background or what they will graduate with is a CTE diploma I guess is the best way or at least CTE background- Career Technical Education in ag bioscience.”

Further, they had classes on plant and animal biotechnology, bioresearch, science and technology of foods so in these areas they were trying to incorporate that across the board in all of their classes, and it’s still a work in progress, even in the sciences so they were trying to develop projects. Another administrator mentioned, “Why we are adding a greenhouse, so we can play around with different agricultural techniques and bring in other businesses...”

Another participant completed her idea and emphasized their curriculum and how much new knowledge is important for them and reported,

“And show them how each discipline has a different aspect in looking at things for bioresearch that sustainability is the overall theme of the whole class and then we look at different things from making biofuels and showing them how they can be food and fuel and not necessarily food vs fuel like most consumers assume.”
Another participant exemplified the topic of the curriculum and how they attempt to show real situations in their educational plans. They stated, “We kind of try to create that so they can see what is a dried distiller grain through ethanol production and where does that go, what do you use it for? It was explained that, “highlighting any topic in our curriculum is important”. For instance, in one of the courses the administrator spoke about the importance of fish in Ohio as an important product in the state and said, “That’s why we are looking at aquaculture and aquaponics because Ohio has 250 fish farms.

Theme: Programmatic design incorporated community involvement and consequently provided valuable networking opportunities for participating students.

One of the main purposes of the program was to make experiences that would ultimately help students in their career pursuits. One way that program administrators aim to develop this purpose is through effective network opportunities for students. A participant stated that

“With all the environmental issues especially with the different problems like the clean water act and the different bills, the manure application that they are looking at, to start those conversations with not just amongst farmers but also consumers by attending the commodity classic a couple years ago, and talking to farmers as a city person, and then coming and teaching in a school that is an ag/bioscience based stem school”.

This means administrators had communication with local farmers and consumers, although that is not enough. Participants had wider views and they emphasized that having a wider network is vital because this issue is important and it has connection with
everybody. One of the participants believed that, “Well going along with that, are many schools teaching about you know being stewards or being environmentally conscious” and even highlighted the role of students as the consumer. They focused on a wider network and constantly added, “most of the consumers going out there, I mean businesses- they’re not going to want to change unless the consumer market changes like as far as organic is getting more popular and gluten free is getting more popular, but that’s consumer driven because the consumers want that.” This means this issue requires a broad network and communication to extend sustainable agriculture. A participant considered the role of students in the families. The teacher said,

“Teachers are role models for the kids. Working on a sustainability project to drive a waste initiative at the school, that’s not only encouraging things like recycling, and composting, but getting the kids to understand why that’s important and hoping that they will take those practices back home and share it with their families.”

This means teachers can have an effect on students’ families.

Theme: Experiential aspects of programmatic design fostered personal growth in participants.

Personal growth was a topic that quickly appeared from the interviews. The program’s experiential environment and student-centered nature developed management skills, leadership skills, and confidence in most of the students. Many participants focused on the responsibilities associated with living and working in this environment.
Therefore, the teachers tried to make connections between real challenges in sustainable agriculture areas and their students’ lives. All of the participants agreed with personal growth. They used different explanations, but the goal of all definitions was growth. For instance, a teacher stated,

“Our population” and “we need to” and added, “it means the world and everyone in general for me. And as an educator, it’s one of the things I really focus on is making sure the future generations understand the impact they are making now and what has been already done… has already happened.”

Another person highlighted personal growth and said, “I think if we are going to promote change we must first assess our own definitions of what that means before we can appropriately educate our young people to make that change. We have to know what it means to us”.

One participant cited,

“Well it raises a question in my mind that I think of all the time of how do we educate our students to get them to care enough to change their daily habits because they know what the problem is or they should know or we might try to teach them what the problem is. However, they have some responsibility”

Another participant explained, “But how do we get them to care to change their daily habits to be stewards of the earth and the same for us as adults too”. This means they need to update their information by in-service training and personal growth. Another participant pointed out looking for students’ problems and declared, “we design our curriculum. Sometimes it’s by need. I think this one was need. We just started to notice
in here that we aren’t using our resources we’re throwing a bunch of stuff away so just hearing student feedback”.

Theme: Experiences in an experiential learning environment enhanced participant understandings of their environment.

A majority of participants believed that their teaching approaches in the program allowed students to confirm or reassess their environment and understand their career aspirations. For instance, participants explained sustainable agriculture and how they tried to explain serious and tangible problems for their students. One participant described Environmental Sustainability:

“I said the management practices in use of land and the environment to ensure the ongoing quality and health of that environment.” Another participant described, “we have lots of environmental issues such as the Clean Water Act and the different bills…the manure application that they are looking at. To start those conversations, not just amongst farmers but also consumers, by attending the commodity classic.”, then added, “A couple years ago, talking to farmers as a city person, and then coming and teaching in a school that is an ag/bioscience based stem school” and said “what are they doing and looking at? What is affecting our water quality? You know, you can’t put it all back on the farmer and what practices are they doing that are sustainable for their area, and just look at what else... How are we as consumers going to be part of that decision?” Another person emphasized,

“We all are a part of clean water, clean air, good food, not just one group.
Maybe part of it is some people still don’t think climate change is real so maybe having a conversation about sustainability in agriculture would convince people who may not believe that the climate is even changing”.

Considering feedback was also important for the teachers, and they believed that it can increase students’ participation. One teacher claimed, “We have a few protocols that we’re just starting off that help us at least give feedback to one another as far as a project goes.”

Teamwork was substantial in this school, and teachers are trying to participate with each other. One participant declared, “if we see that one teacher is doing a project that we could take part in, that makes it a lot easier.” And collaboration among teachers is critical. One of them pointed out that “Generally collaborates continuously as far as supplies and what they are doing so that we are over-lapping. And whatever ideas are shared that have been successful before or things like that.” Another participant believed making an atmosphere of teamwork is important. “You can see what each individual teacher is also thinking ahead for projects that you can either add into or at least you know what everybody is doing with their larger projects and I think that has really helped the teachers to see what others are doing.”

At the end of any educational process evaluation is substantial because it has effect on the amount of participation. The evaluation should be based on the curriculum and what information was taught. It is one vital part of the teaching process. Another teacher explained evaluation in the Academy. “We are not evaluated through OTES which most high schools… Most schools are in Ohio” and emphasized their own evaluation protocol through their director.
Most of the participants believed that teaching is a methodology. One of the participants discussed different teaching methods such as hands-on, problem based, project based learning, modeling, and in social studies indicated that they use the Socratic seminar a lot, and then added, “it depends on the day and the class topic. For example, sometimes students work independently on their computers or it will look like chaos, but direct instruction and lecture are less than other teaching methods because lecture is boring for them and they will fall asleep”. Choosing the right teaching method is crucial, and they emphasized group teaching methods rather than individual because it has effect on students’ participation. Another participant believed choosing a teaching method depends on the topic in a specific day and added, “So you might have a portion of a…day being lecture with…”.

Specifically teachers considered the main topic, which is sustainable agriculture and how they were teaching this topic. One of them stated, “Asking how can we make the school zero waste and then leave it up to the students to working with them to get to that goal”. Another of the participants continued, “Field trips around the school to find what our needs are or to see where our biggest areas of waste are so they are all over the place with their ideas from like changing the lunch trays to being reusable lunch trays.”

Teachers of the bioresearch class and animal and plant biotechnology exemplified their activity in their classroom and said, “they are doing hydroponics and then environmental sustainability...” and to choose the topic of each syllabus is substantial for them and said, “students have remarked about how much waste they see either in the cafeteria… We have a kind of a recycling program right now”. This school has a different
educational system and the teachers can design their educational planning. A teacher explained,

“All the teachers have complete autonomy, so if they need to change something, they can. They aren’t tied to any sort of structure. So that helps with scaffolding too…” They discussed using different educational methods. “We are teaching them multiple ways to learn and to do things so we are more or less helping them to be better problem solvers or deductive thinkers or being able to extrapolate data so that they can come up with some sort of reasoning behind it….”.

Integration of Qualitative and Quantitative Data

Objective 1: Describe teachers’ perceptions of sustainable agriculture topics

The results of the quantitative portion of this study indicated that GISA teachers believed that sustainable agriculture, specifically, development of healthy soils is important for sustainable agriculture. They perceive that exchange of knowledge about locally designed technologies among producers promotes sustainable agricultural practices, and that sustainable agriculture is evidenced by promoting recycling of renewable natural resources. In addition, the findings of the qualitative research showed that teachers were serious about climate change, their environment, and maintaining enough natural resources for the next generation.

One teacher mentioned that the growing population is an essential element to consider sustainable agriculture because without natural resources, producing food for the next generation is difficult. Further, a teacher highlighted the role of the market to extend sustainable agriculture and added that consumer choices have an important role to
develop sustainable agriculture, specifically with emerging gluten free and organic foods in markets.

In addition, when GISA teachers defined agriculture, environment was a theme in their definitions. Teachers highlighted environmental problems as serious challenges for a new generation. Regarding Social Reconstruction Theory, the teachers’ concern for answering a critical societal question in their curriculum is a model of implementation for the theory. For example, The GISA teachers shared that during their teaching, they have incorporated these challenges because they do not want students to forget the necessity of solving these critical societal issues. Additionally, the qualitative research observation indicated that teachers had incorporated an assignment, designing a hydroponic project with small, disposable containers that captured the essence of the critical issue while using components of the issue in the curriculum. In the assignment, students were assigned a subset of urban farming hydroponics since teachers believed that in the sustainable environment they would transfer their beliefs into the students’ assignments and experiential learning approach. As a result, evidence was provided through both qualitative and quantitative data collection, in a triangulation, teachers perceived sustainable agriculture to be important.

Objective 2: Describe teachers’ perceptions of sustainable agriculture practice

According to the results of the quantitative research component of this study, these practices were important to the teachers: soil testing, use of green manure, conservation tillage, integrated pest management, mechanical weeding, reduced rates of herbicide application, reduced tillage, and use of animal manure for enriching the soil.
Further, the qualitative research component of the study revealed that the teachers highlighted practices toward sustainable agriculture such as soil testing, manure application, and clean water and air. In addition, based on qualitative research, GISA teachers considered using suitable technology and academic recourses to apply sustainable agriculture practices. GISA teachers mentioned that they require in-service training to update their information on sustainable agriculture topics, practices, and methods for teaching the concepts. Therefore, the results of the quantitative and qualitative research methods indicated that teachers might not be teaching some of the possible topics in sustainable agriculture because they do not have enough information about practices and methods for teaching.

Objective 3: Describe the sustainable agriculture topics taught by Global Impact Stem Academy teachers

According to the results of the quantitative research data collection, GISA teachers taught renewable sources of energy, wildlife conservation, protection of wetlands, recycling agriculture waste, narrow strip intercropping, nitrogen allocation, rotational grazing, and food safety. Based on the qualitative research data collection, GISA teachers started with psychological concepts in the classrooms. They indicated that because their audiences were young, they were representatives of their family and, therefore, could educate their family and, eventually the society. Specifically, they reported that they teach plant and animal biotechnology, bioresearch, science and technology of foods as their topics in sustainable agriculture. The results of both the
qualitative and quantitative research methods confirmed that the GISA teachers are engaging students in sustainable agriculture topics.

Objective 4: Describe classroom methods used by teachers to teach sustainable agriculture

Based on the findings of the quantitative research methods, GISA teachers utilized group discussion, hands-on-learning, projects, websites, videotapes, and demonstrations to deliver content related to sustainable agriculture. These methods are a combination of individual and group methods. The variety of delivery methods used by GISA teachers, offer students engagement opportunities beyond the traditional lecture method. In addition, the qualitative research data analysis indicated that experimental learning and student centered approaches were the most substantial teaching approaches for GISA teachers. These experiential learning opportunities allowed participants to apply knowledge in their real lives. The teachers consistently highlighted the program’s experiential learning opportunities and encouraged participants to apply knowledge in the solving critical societal issues which modeled the Social Reconstruction Theory component of the curriculum. The researchers saw evidence of the use of different educational methods such as group discussion, lecture, and peer mentoring during the classroom observation. An important philosophy for the GISA teachers was that students had an opportunity to apply their new information in their personal lives. As a an application of Social Reconstruction Theory, assignments at GISA expected concepts to have realistic applications of critical societal questions where students were expected to
utilize the information presented throughout the curriculum in semester-long, school-based, and community-based authentic projects.

The interview with GISA teachers pointed out that they use hands-on, problem based, and project based learning. The results of the quantitative data collection were similar to the findings of the quantitative data collection; GISA teachers in this new, agbioscience high school preferred to use group-teaching methods to deliver information about sustainable agriculture.

Finally, the quantitative research data collection was useful for the researchers to achieve accurate data in a limited timeframe while the qualitative data collection, specifically the classroom observation and the focus group interview, provided further deep insight that the quantitative method could not. For instance, in the quantitative research method, through closed questions, researchers were not able to identify the traditional approach that GISA teachers used to teach sustainable agriculture topics, but the qualitative research data collection added this insight. Also, in the focus group interview, teachers discussed the teaching methods and approaches, so more information, such as student centered views, the processes used for evaluation, teachers’ connection with the local community, academic centers, and recourses were revealed. Consequently, the two research methodologies complimented the research in addressing the objectives of the study.

The combined qualitative and quantitative research methods contributed to examining the Global Impact Stem Academy teachers’ unique utilization of Social Reconstruction Theory in this unique, new agbioscience high school. Because this high
school is developing in its contribution to the community, the two research methods contributed to the data collection and analysis.
Chapter 5: Conclusions, Recommendations, Discussion

Researchers have recognized that teaching sustainable agriculture in areas such as ecological, social, and economic systems will assist students to realize the connection among these systems (Francis & King, 1994; Santone, 2003; Santone, 2004). Students will potentially also recognize the importance of sustainable agriculture. Teaching sustainable agriculture concepts in high schools can be validated by using Social Reconstruction Theory as a philosophical approach to using social issues as critical questions in developing high school curriculum around societal needs. Teaching sustainable agriculture in high schools can assist students in developing technical, communication, and workforce skills to face the challenges in the agricultural sector. The goal of this chapter is to summarize the overall study, discuss findings, state conclusions, and make recommendations.

Purpose of the study

The purpose of this study was to describe perceptions of Ohio high school teachers toward sustainable agriculture. The specific objectives guiding the study included:

- Describe teachers’ perceptions of sustainable agriculture topics.
- Describe teachers’ perceptions of sustainable agriculture practice.
- Describe the sustainable agriculture topics taught by Global Impact Stem Academy teachers.

- Describe classroom methods used by teachers to teach sustainable agriculture.

Procedure

A census of the 17 teachers at Global Impact Stem Academy, a new high school with an agriculture foundation, specifically agbioscience, was chosen to replicate an Iowa State study of sustainable agricultural education (Muma, 2006). This research is a contribution to previous studies and was designed to measure variables in an agricultural science high school, Global Impact Stem Academy. A descriptive research design, utilizing quantitative and qualitative methods was used to accomplish the objectives.

Major Findings

Findings from this study included:

1. The majority of the teachers at GISA who responded to the survey were female (88.9%).

2. The majority of teachers at GISA who responded to the survey had obtained a Master’s degree (77.8%), while all teachers held a Bachelor’s degree (22.8%)

3. The average number of years teachers had taught in the Global Impact STEM Academy was 2.5 years (the school was 2.5 years old).

4. Teachers at GISA who responded to the survey and whom participated in the focus group or were observed in his/her classroom, on average, agreed with statements
supporting beliefs about sustainable agriculture. In addition, they emphasized ecological and social dimensions.

5. Teachers at GISA who responded to the survey and whom participated in the focus group or were observed in his/her classroom had positive perceptions toward sustainable agricultural practices.

6. Teachers at GISA who responded to the survey and whom participated in the focus group or were observed in his/her classroom rated sustainable agriculture practices with ecological and social dimensions higher than other biological and environmental practices.

7. Teachers at GISA who responded to the survey and whom participated in the focus group or were observed in his/her classroom generally believed in teaching selected sustainable agriculture concepts which they only taught sustainable agriculture concepts to a moderate extent.

8. Teachers at GISA who responded to the survey and whom participated in the focus group or were observed in his/her classroom indicated they used discussion, hands-on-learning, and project to a high extent to teach agriculture topics.

9. Generally, teachers at GISA who responded to the survey and whom participated in the focus group or were observed in his/her classroom used individual educational methods in teaching to only a low to moderate extent.

Demographics

Most of the teachers in Global Impact Stem Academy had completed Masters Degrees. However, the findings of Straquadine (1997), from a national study, generally
indicated that the proportion of the population with the BS and MS levels of education was about the same, indicating that education levels of teachers at GISA were above the national norms.

Muma (2006) reported that approximately 50% of the agricultural education teachers in the Iowa State study had not lived on a farm or worked full-time on the farm. As a result, it was concluded that these teachers have no connection with the local community and therefore have little basic, hands-on information about sustainable agriculture. Generally, Muma’s results for the moderate number of years teachers taught agriculture showed an assessment of the variable similar to the results of the previous studies (Koralalage, 2001; Okeafor, 2002; Sikinyi, 2003).

Summary of Findings by Objective

Objective 1: Describe teachers’ perceptions of sustainable agriculture topics

One of the objectives of this study was to describe the perceptions of teachers toward teaching sustainable agriculture. Most of the teachers agreed with a sustainable agriculture philosophy. The ranking of the means of beliefs about sustainable agriculture supports teacher’s positivity toward sustainable agriculture. Some studies on beliefs about sustainable agriculture have similar findings. The studies include university farmers and faculty (Beus & Dunlap, 1992), agriculture teachers (Agbaje, Martin, & Williams, 2001; Okeafor, 2002; Straquadine, 1997; Udoto & Flowers, 2001), and agricultural extension educators (Conner & Kolodinsky, 1997).

The importance of the social and ecological aspects of sustainable agriculture in the belief of teachers toward sustainable agriculture shows that education can utilize
economic, social, and ecological systems perspectives to increase students’ knowledge and skills toward sustainable agriculture (Williams & Dolliso, 1998). This importance of the social and ecological aspect of sustainable agriculture by the teachers can combine knowledge for appropriate solutions and show the problems in the agriculture sector. The deficiency of any established differences in the means of teacher perceptions toward sustainable agriculture seem to agree with a trend toward similar demographic differences such as their education, gender or the number of years teachers worked and lived on farms (Muma, 2006).

The combination of science and its application in teaching agriculture curriculum has boosted the value of agbioscience education. This can be attributed to the fact that scientific disciplines and applications have enhanced levels and interests of students who attend agriculture classes, specifically with crucial interests in agbioscience (Chiasson & Burnett, 2001; Conroy & Walker, 2000; Thompson, 2001).

Given Social Reconstruction Theory’s philosophy toward using critical questions to construct curriculum, to have reasonable answers to the food and fiber problems of the 21st century, the National Council on Agricultural Education (1995) recommended that agricultural science teachers should enhance their curriculum by introducing sustainability topics to encourage a holistic view and using methods that introduce agriculture (Vehoviak, Adams, & Bruening, 1994). Another way to enhance the curriculum was by utilizing different disciplines and structures that address social problems and requirements. GISA embraces these components by insuring every day that students are feeling these challenges and are recognizing these challenges in the process of learning.
Using different discipline approaches can courage decision-making in the agriculture system. GISA’s philosophy is to accelerate developments in the agricultural sector, which are not viewed as significant currently, but the immersion of sustainable agriculture into the high school agbioscience curriculum is necessary.

Thus, there is a need to elevate high school agricultural curriculum and to adjust to social change such as sustainable agriculture progress (Williams & Dolliso, 1998). Sustainable agriculture must be involved in high school agricultural plans in the 21st-century agriculture sector, to prepare graduates for work or college. Hamilton (1999) believed that there is an ability in the principles of sustainable agriculture in addressing the environmental and economic issues facing the agricultural sector. He stated that as long as there is no relationship between the natural resources and the food production systems, our future is in unclear. Kirschenmann (1997, as cited in Leopold Center for Sustainable Agriculture, 2000) reported, “One has to become a society of lovers of the soil...” (p. 6).

As early as 1997, Williams and Wise suggested that steps must be taken to mix high school agricultural education curriculum with new knowledge about sustainable agriculture practices. They indicated that innovative teaching of sustainable agriculture helps students experience sustainable practices. It is advocated that these processes assist student interest in learning sustainable agriculture (Feldman, 1999; Francis & King, 1994).

Social reconstruction, as a theory, attempts to show social challenges presented as critical questions in which agbioscience teachers identify a need in society. Teachers get involved in the community to find the issues. This would be anticipated to happen in the
case of sustainable agriculture, since the public sees the vital challenges in the agriculture sector. Social members, who accept a social reconstruction curriculum theory, can understand the value of a social group learning and utilizing teaching in ways that are adjusted to the specific situations of the challenge for learning (Dewey, 1938; McLeod, 2005; Tam, 2000).

This research has identified that teaching sustainable agriculture required having positive perceptions toward sustainable agriculture practice. Since there are positive beliefs of agriculture teachers in this research toward sustainable agriculture, it is anticipated that they have the motivation to teach sustainable agriculture and are anticipated to prepare teaching-learning methods that are vital to the social challenges in agriculture.

Objective 2: Describe teachers’ perceptions of sustainable agriculture practice

The second objective of this study was to describe practices of high school teachers’ skills and knowledge toward sustainable agriculture. The analysis indicated that all teachers who either answered the questionnaire, participated in the focus group, or was observed in the classroom deemed that they taught sustainable agriculture content using a variety of approved practices. Nevertheless, the emphasis was put on teaching certain items such as soil testing, green manure crops, soil erosion control, soil conservation and mixed cropping, and management of soil fertility.

These findings supported Hunters (1995) study reporting that teaching skills are more crucial than materials, books, and equipment. She deemed that enhancing teachers’ skills can evolve teachers, specifically in their research finding related to Farmer
Perceptions of Soil and Water Conservation Issues. Ommani (2011) claimed that there is a requirement to enhance education and teaching skills when managing agricultural chemicals.

The high mean scores for sustainable agriculture practices for the teachers at GISA means that the teachers at this new agbioscience school agreed with questionnaire items that supported positive attitudes toward sustainable agriculture practices. The general agreement toward sustainable agriculture, specifically the top four mean ratings, included sustainable agriculture practices that highlighted social and ecological aspects of sustainable agriculture practice. Agbaje et al., (2001) and Gamon, Harrold, & Creswell (1994), showed that sustainable agriculture concepts were highlighted by economic aspects.

Researchers of science teachers’ attitudes toward agriscience found agreement with these findings (Balschweid & Thompson, 2002; Wamick, Thompson, & Gummer, 2004). The deficiency of any mean with other means shows sustainable agriculture practices by teachers have connections with different sustainable agriculture variables. For example, individuals are predicted to associate specific topics (agricultural practices) more than with global objects (Augoustinos & Walker, 1995; Fishbein & Ajzen, 2003) such as sustainable agriculture practice. This is because beliefs, attitudes, and perceptions have connection with each other. This result also implies that teachers may be expected to infuse sustainable agriculture topics into other aspects of the agriculture.

Since some teachers stated that they did not approve of selected sustainable agriculture practices, there might be two visions among teachers in the teacher population regarding their attitudes toward sustainable agriculture practices. Previous studies
indicated that there were teachers who approve and teachers who disapproved of various sustainable agriculture practices (Conner & Kolodinsky, 1997). Such a view may happen among teacher populations because it is naturally occurring among community members (Beus & Dunlap, 1990). The existence of a dichotomous division among teachers regarding selected sustainable practices may hold clues to possible differences among teachers with respect to their chosen teaching practices and their consequent predispositions toward using a variety of teaching practices. Therefore, regarding Social Reconstruction Theory, overall, the agbioscience teachers’ perceptions about selected sustainable agriculture practices did not support social reconstruction curriculum theory, unless there were opportunities for the teachers to be autonomous in their choices of the practices they used to teach topics that were relevant to them.

Objective 3: Describe the sustainable agriculture topics taught by Global Impact Stem Academy teachers

The extent to which teachers taught selected sustainable agriculture topics indicates that teachers in this study perceived that sustainable agriculture should be taught, and chose practices for which they could advocate sustainable agriculture concepts. Past researchers have found similar results (Agbaje et al., 2001; Okeafor 2002, Muma, 2006).

The findings from the statistical analysis showed that teachers know about basic concepts of teaching sustainable agriculture and choose various methods for teaching the concepts. Gamon and Scofield (1998) in a study on perceptions of sustainable agriculture with youth and new producers, found that the teachers considered the sustainable
agricultural practices and chose teaching methods accordingly. In a study of the perceptions of Iowa secondary school agricultural education teachers toward sustainable agriculture, Williams (1997) identified the same result. He claimed that teachers considered the concept and objectives regarding sustainable agriculture and then sought in-service training for motivation, as well as acquired enough materials to be successful in teaching sustainable agriculture topics. These approaches enabled teachers to teach sustainable agriculture.

The topics taught most frequently by GISA teachers included recycling, renewable resources, rational grazing, and narrow strip intercropping. Early on, agriculture teachers and students recognized these topics as having the potential for effecting sustainable agricultural practices (Williams, 2000). Other studies, however, found that teachers taught sustainable topics that were needed by farmers to be more economically driven (Agbaje et al., 2001; Gamon et al., 1994). In addition, Fretz (1991) found that teaching topics such as water quality, recycling of agricultural wastes, soil conservation, and wildlife conservation, could highlight the environmental challenges facing conventional agricultural systems.

Ranking of different topics about sustainable agriculture depends on the goals of the curriculum and how much the individuals in the community are engaged in these practices. Nevertheless, the results from the GISA agbioscience teachers are that their ratings of the sustainable agriculture topics overlapped with those that were prevalently taught in other curricula. Other Biotechnological topics such as insect-resistant crops were also taught.
Most of topics taught by GISA teachers who responded to the questionnaire, participated in the focus group or were observed, had environmental and economic implications. Generally these teachers taught topics highlighting, human wellbeing such as economic dimensions or social dimensions of sustainability. Previous studies (Alonge & Martin, 1995; Gamon, Harrold & Creswell, 1994) concluded that teachers or educators taught about sustainability while focusing on farm economics rather than social or environmental issues. In addition, Williams (2000) and Williams and Wise (1997) reported that teachers were teaching sustainable topics with social dimensions of sustainable agriculture and ecological concepts.

In this study of GISA teachers, although the study participants believed in sustainable agriculture, they did not teach a large array of sustainable agriculture topics in their classes and sustainable agriculture is not a specific subject matter listed in their curriculum. This result is the same result as Muma (2006).

In terms of a social reconstruction philosophy, the teachers indicated a high support for topics that engage students in critical issues around community awareness. Sustainable agriculture topics are among the prevalent issues facing society, but have not yet been addressed in verbiage that seems relative to this group of agbioscience teachers.

Objective 4: Describe classroom methods used by teachers to teach sustainable agriculture

The fourth objective of this study was to describe teachers’ use of teaching methods for delivering sustainable agriculture content. Teachers were asked to indicate the teaching methods that they are utilizing in their classrooms for delivering information
about sustainable agriculture. The analysis for this study showed that teachers used a variety of teaching methods to transfer some information about selected sustainable agriculture topics. The use of teaching methods to teach sustainable agriculture was moderate (overall $M = 3.64$) which is not the same overall mean for teachers’ perceptions toward teaching sustainable agriculture topics.

Selecting different teaching methods from one topic to another depends on the context of the topic (Dewey, 1938; Liu & Matthews, 2005). This information supports a social reconstruction curriculum model. Teachers would be predicted to use different teaching methods when following a social reconstruction theory.

In previous studies, teachers used a variety of teaching methods to teach sustainable agriculture topics, but most of the teachers have used traditional lecture-type teaching methodology (Dewey, 1938). However, Okeafor (2002) and the findings of the GISA teachers indicated that teachers utilized a variety of teaching methods to transfer sustainable agriculture topics. Specifically, in this study, educational methods that need high hands-on participation as well as audio-visual methods, group discussion, debates, and digital electronic visuals were used.

According to the results of his study, changes in our communities create in-service education needs that are important for solving societal challenges. Educational needs assessment of teachers is important. It has been suggested that in-service programming can assist educational planners in determining non-instructional and instructional programs.

Pearce (2004) wrote that teachers require varying amounts of time to evolve in their educational skills. He believed that the goal of teacher in-service education training
was independence and competency. He further advocated for in-service education that can sustain teachers by preparing them to learn how to enhance their teaching. Okeafor (2002) explained that the basis for in-service training programs is often a deficiency model that can build on existing programming to identify needs.

In designing a teacher-centered in-service education model, inspiration was gained from Weber's (1996) approach to in-service that used the living soil to make a teacher-centered in-service educational curriculum development. His goal focused on environmental factors to strengthen existing curriculum through the subject matters of language, natural resources, earth, science, speech, environmental sciences, biology, arts, agriculture, history, and conservation (Okeafor, 2002).

The in-service education model advocated can be used as a Social Reconstruction Theory model of implementation at a school like GISA. Implementation can assist teachers in developing their high school curriculum through integrating the critical social questions that are required for an individual, community, and institution to advance the teaching methods necessary for advanced sustainability practices. The model explains how agricultural education teachers learn and master basic information and skill on a broad view that enables them to introduce new information. For instance, in a sustainable agricultural view, the approaches could include personalizing information via different learning activities cooperative learning, literary analysis, and case studies. By accomplishing in-service training, teacher would be developing teaching approaches with the potentials of increasing student learning (Muma, 2006) through a reconstruction approach of applying critical questions to drive the skill development.
Conclusions

The research study was designed to describe the perceptions of high school agbioscience teachers and how they were effected by variables such as their demographic characteristics, perceptions and practices toward sustainable agriculture. A descriptive survey design was implemented to develop an accurate idea about sustainable agricultural practices as considered by teachers at the new Global Impact Stem Academy. Participants in the study were teachers from a census of the GISA teachers. The school was chosen because of their agricultural foundation and philosophy. Descriptive characteristics of central tendency of this study such as frequencies, means, and standard deviations, mode and median were considered.

The questionnaire used in this study was from Straquadine (1997) and Muma (2006) in their research of agricultural education teacher's recognizing an instructional curriculum. Questionnaires with cover letters for each teacher were provided. All high school teachers in GISA were invited to participate. Participants responded based upon their knowledge about sustainable agriculture. Follow-up efforts were made twice to non-respondents.

The findings of this study were that GISA teachers perceived that teachers need more information about sustainable agricultural practices. The results of this research concluded that teachers in GISA had less information about sustainable agricultural practices than they did about conventional production practices. Nevertheless, teachers recognized that sustainable agricultural practices have benefits such as boosting profits and protecting the environment. Teachers recognized that sustainable agricultural practices will have a gradual adaptation toward protecting the environment.
Agbioscience teachers preferred to reduce chemical fertilizers in preparing enough food for the current population.

The level of knowledge about topics, practices, and teaching methods in sustainable agricultural were different among the GISA teachers. The teachers had their own individual understandings of sustainable agriculture. GISA teachers in this study explained that they have adequate information toward sustainable agricultural practices and principles. However, it is possible that more information can be helpful to increase their knowledge about sustainable agriculture.

As new knowledge of sustainable agricultural practices evolve, agricultural education teachers can use them in combination with this new knowledge to infuse into the existing curriculum. Field demonstrations, in-service programs, and workshops to help teachers will improve this procedure. Recognizing new methods and their implications in different sustainability systems will evolve. In early studies of sustainable agriculture curriculum, Whent (1997) claimed that students had a more positive perception toward sustainable agricultural practices after they contributed to sustainable agriculture research. William and Wise (1997) reported a similar finding. These connections with students reinforce A Social Reconstruction Theory in which critical social questions were scientifically studied, which led students to desiring continued updated information about sustainable agriculture.

High schools have had an opportunity to adopt sustainable agricultural practices in local societies. Involving a younger generation in the adoption process of sustainable agriculture has facilitated the implementation of sustainable agriculture practices. Thus,
the future curriculum re-design will consider environmental stewardship, social responsibilities, and water quality as part of the sustainability content.

This study revealed that high school teachers at GISA, are motivating students toward sustainable practices by using the Social Reconstruction Theory. Teachers are using society’s biggest issues as hands-on projects for students to grapple with the questions facing their community. Students’ curriculum is enhanced by student participation in research projects, demonstrations, and fieldwork about sustainable agricultural. These findings highlight the need to combine sustainable agricultural topics in the agbioscience teacher education programs.

Applying Social Reconstruction Theory

Social reconstruction is used to indicate problems and to write curriculum to address those problems. Agbioscience teachers at GISA have identified a need to consider main challenges in the society and to get involved in the social communication necessary to be a part of facing the challenges.

The results of this study showed that teachers perceived that sustainable agriculture is a critical question facing society. From this study, it is also clear that the teachers are writing curriculum and implementing teaching methods that are contributing to educationally challenging sustainable agriculture.

As Kolb wrote, learning in a reconstruction philosophy is constructed of mental concepts which are most effectively implemented when learners are supported in contextually-based experiences that are individually meaningful (1984). As such, findings showed that teaching sustainable agricultural concepts at GISA is based on
preexisting social questions that the teachers have actively reconstructed to effectively build upon learners’ intellectual development. The curriculum is implemented to encourage contextual experiences that are personally meaningful.

Specifically, in this research, GISA teachers identified social values in the agriculture sector that had connections with local society. According to Social Reconstruction Theory, this can be predicated to happen since the teachers know about the issues of sustainable agriculture in the community and have pre-communication with the public. The teachers can share current challenges with local society especially through students, who are the representatives of their families and community in the school environment. According to Social Reconstruction Theory, the results of this study have implications to curriculum developers, education specialists, teachers, instructional materials developers, and educators.

To resolve societal issues by making the connection from curriculum to society is a slow resolution that requires time. This process can be achieved by continuing to influence the agriculture curriculum at GISA. The penetration of sustainable agricultural practices into the curriculum is rarely automatic and may take several years to be one part of the school’s educational programming. In addition, members of society, who are funding and contributing to this school, are anticipated to accept a social reconstruction curriculum theory. By doing so, the community begins to understand the value of social group learning and begins to utilize teaching methods that are adjusted to the specific situations of the challenge for learning.
Recommendations and Implications

The following recommendations and potential implications were made based on the results of this study:

1. Since most of the teachers at GISA who responded to the survey and whom participated in the focus group or were observed in his/her classroom reported that sustainable agricultural practices can be useful for their communities, they need curriculum enhancement support and resources. To achieve this goal, more studies in sustainable agricultural practices are required to show the potential challenges for adopting new practices toward sustainable agriculture. It is substantial that these researchers consider local farmers and teachers to recognize strategies and barriers for adopting sustainable agriculture practices based on environmentally safe, beneficial, and profitable approaches.

If more resources are provided for expanding curriculum, teachers will be able to integrate sustainable agriculture topics that are not currently being addressed. In addition, there is potential for deepening the level of understanding about the topics that are currently being addressed. For example, more hands-on and authentic applications of the content can require more resources and modifications to the curriculum.

2. Some teachers in this study indicated that they did not consider sustainable agricultural information as an area of study in their curriculum since they do not have enough information about sustainable agricultural practices. Therefore it is important to consider in-service teachers training programs toward sustainable agricultural practices.

If teachers are provided with opportunities to travel to conferences to engage with experts on sustainable agriculture, their acquired knowledge will influence the next
generation of citizens. In addition, bringing people to the school to further challenge teachers’ level of expertise, can benefit the community by inviting community to the speaking events.

3. Through this study, it was indicated that teachers at GISA who responded to the survey and whom participated in the focus group or were observed in his/her classroom felt that various forms of media can help teachers update their knowledge and information about sustainable agriculture so research institutions, agencies, and educational organizations can disseminate sustainable agricultural knowledge. Further, the electronic media can play a significant role in distributing information to the larger audience. There should be participation among the different sources of sustainable agricultural information so teachers can participate in the process of exchanging information. Research organizations, Cooperative Extension Service, and Land-grant universities, can play important roles in this process so teachers can have access to relevant information about sustainable agricultural information.

   If large media sources positively present sustainable agriculture concepts to consumers, teachers can exponentially influence communities to engage in sustainable agriculture practices. Additionally, there is reciprocal benefit to communities as the school, the teachers and the students become reliable sources for the media to use in spreading positive examples of sustainability.

4. Teachers at GISA who responded to the survey and whom participated in the focus group or were observed in his/her classroom in local communities should be involved in research (more/continued) toward sustainable agricultural practices. Teachers have the unique responsibility to prepare the new generation in their community. Involving
teachers can create motivation for them to be more active in all dimensions of sustainable agriculture practice.

If more research is being conducted at younger ages, a better understanding of the value of research will perpetuate the next generation of citizens. In addition, if the research is focused on various aspects of sustainable agriculture, the new knowledge will benefit the current and future generations of Ohio citizens.

5. Students at GISA have connections with other parts of society, which include family, communities, and others in which information can be shared about sustainable agriculture. Sustainable agriculture has a connection with all of society.

If the students at GISA begin to live sustainably at school on a daily basis, the habits they form will influence their families. As families become more sustainable in their habits, the communities will be influenced by families asking for more community-wide programs, educational events, and political guidelines and policies.

Summary

This research has focused on a new agbioscience high school and its teachers’ perceptions of sustainable agricultural education. A social reconstruction theory provided the foundation for describing the teachers’ perceptions toward sustainable agriculture curriculum development and implementation of sustainable agriculture knowledge and practice. The teachers in this study perceived that sustainable agriculture practices are important. They are using engaging classroom methods to authentically influence their students’ knowledge and engagement with sustainable agriculture. By working with teachers, the best possible opportunity exists to reconstruct curriculum and
delivery for influencing the next generation of this school’s citizens, community members, and beyond.
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Appendix A: Informed Consent Letter
Dear study participant:

Thank you for agreeing to complete the survey for my dissertation work at The Ohio State University. Completing the survey should take approximately 10-15 minutes.

My name is Sharmin Faraj and I am interested in learning about the ways in which teachers in many different classrooms, specifically as it relates to agriculture, are presenting sustainability. Therefore, I am replicating a study that was conducted in 2006 at Iowa State among high school agriculture teachers.

The purpose of this study is to describe the perceptions and behaviors of teachers of many subjects toward teaching about sustainable agricultural practices. The objectives guiding the study are to:
- Describe teachers’ general perceptions of sustainable agriculture topics.
- Describe teachers’ perceptions of sustainable agriculture practices.
- Describe the sustainable agriculture topics taught by teachers in general.
- Describe the classroom methods used by teachers in general to teach sustainable agriculture.

Thank you, again, for your consideration in assisting in the completion of my dissertation work.

Sincerely,
Sharmin Faraj
Appendix B: Instrument
Survey instrument

1) General beliefs of teachers toward Sustainable Agriculture

Indicate the extent you agree or disagree with each statement regarding sustainable agriculture by circling the appropriate number on a 5-point scale (1=Strongly Disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly Agree).

<table>
<thead>
<tr>
<th>General beliefs toward Sustainable Agriculture</th>
<th>1=Strongly Disagree</th>
<th>2=Disagree</th>
<th>3=Neutral</th>
<th>4=Agree</th>
<th>5=Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sustainable agriculture promotes local marketing of agricultural production</td>
<td>1 2 3 4 5</td>
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<tr>
<td>2. Necessary for attainment of a sustainable agriculture</td>
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<tr>
<td>3. Local farming practice success of sustainable agriculture</td>
<td>1 2 3 4 5</td>
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<tr>
<td>4. Sustainable agriculture practices emphasize rural landscape</td>
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<tr>
<td>5. Farm size is related to the farm management</td>
<td>1 2 3 4 5</td>
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<tr>
<td>6. Sustainable agriculture values nature for its own sake</td>
<td>1 2 3 4 5</td>
<td></td>
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<td></td>
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<tr>
<td>7. Sustainable agriculture promotes recycling of renewable natural resources</td>
<td>1 2 3 4 5</td>
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<tr>
<td>8. Innovations in agricultural technology determine the success of sustainable agriculture</td>
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<td>9. Sustainable agriculture indicates low farm capital investment and technology</td>
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<tr>
<td>10. Sustainable agriculture promotes local processing of agricultural production</td>
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<td>11. Agricultural knowledge from extension is important for the success of sustainable agriculture</td>
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<td>12. Crop rotation is important to achieving sustainable agriculture</td>
<td>1 2 3 4 5</td>
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<tr>
<td>13. Local knowledge of farming in a community is an indication</td>
<td>1 2 3 4 5</td>
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<tr>
<td>14 Exchange of knowledge about locally designed technologies among producers promotes sustainable agricultural practices</td>
<td>1 2 3 4 5</td>
<td></td>
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<tr>
<td>15. Integrating diverse crops with livestock enterprises to promotes sustainable agriculture</td>
<td>1 2 3 4 5</td>
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<tr>
<td>16. Sustainable agriculture promotes specialized crop and livestock enterprise</td>
<td>1 2 3 4 5</td>
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<td></td>
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</tr>
<tr>
<td>17. The size of a community impacts development of sustainable agriculture</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Sustainable agriculture reduces need for over reliance on external sources of inputs</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Sustainable agriculture increases returns to farm labor</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Development of healthy soils is important for sustainable agriculture</td>
<td>1 2 3 4 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2) Agricultural Practice

Indicate the extent to which each item is a sustainable agriculture practice by circling the appropriate number on a 5-point scale (1= Strongly Disagree; 2= Disagree; 3= Neutral; 4= Agree; 5= Strongly Agree).

| Indicate the extent to which each item is a sustainable agriculture practice | 1=Strongly; Disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly Agree) |
|---|---|---|---|---|---|
| 1. Soil test | 1 | 2 | 3 | 4 | 5 |
| 2. Use of green manure | 1 | 2 | 3 | 4 | 5 |
| 3. Conservation tillage | 1 | 2 | 3 | 4 | 5 |
| 4. Reduced rates of herbicide | 1 | 2 | 3 | 4 | 5 |
| 5. Integrate pest management | 1 | 2 | 3 | 4 | 5 |
| 6. Mechanical weeding | 1 | 2 | 3 | 4 | 5 |
| 7. Reduced tillage | 1 | 2 | 3 | 4 | 5 |
| 8. Use of animal manure | 1 | 2 | 3 | 4 | 5 |
| 9. Crop rotation | 1 | 2 | 3 | 4 | 5 |
| 10. Narrow strip intercropping | 1 | 2 | 3 | 4 | 5 |
| 11. Fall seeded cover crop | 1 | 2 | 3 | 4 | 5 |
| 12. Herbicide resistance crops | 1 | 2 | 3 | 4 | 5 |
| 13. Nitrogen application | 1 | 2 | 3 | 4 | 5 |
| 14. Row banding of herbicides | 1 | 2 | 3 | 4 | 5 |
| 15. Use of nitrification inhibitor | 1 | 2 | 3 | 4 | 5 |
| 16. Recycling agriculture waste | 1 | 2 | 3 | 4 | 5 |
| 17. Reduced nitrogen fertilizer rates | 1 | 2 | 3 | 4 | 5 |
| 18. Reduced use of fertilizer | 1 | 2 | 3 | 4 | 5 |
| 19. Rotational grazing | 1 | 2 | 3 | 4 | 5 |
| 20. Insect resilience crops | 1 | 2 | 3 | 4 | 5 |
| 21. Use of low input livestock facilities | 1 | 2 | 3 | 4 | 5 |
3. Teaching Sustainable Agricultural Topics

Indicate the extent to which each item is a sustainable agriculture topics by circling the appropriate number on a 5-point scale (1=None; 2=Low Extent; 3=Moderate; 4=High; 5=Very High Extent).

<table>
<thead>
<tr>
<th>Teaching Sustainable Agriculture Topics</th>
<th>1=None; 2=Low Extent; 3=Moderate; 4=High; 5=Very High Extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Water quality</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>2. Recycling agricultural waste</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>3. Food safety</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>4. Protection of wet lands</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>5. Renewable sources of energy</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>6. Wildlife conservation</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>7. Air pollution</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>8. Rotational grazing</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>9. Narrow strip intercropping</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>10. Fall seeded cover crop</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>11. Use of low input livestock facilities</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>12. Row banding of herbicide</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>13. Integrated pest management</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>14. Soil test</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>15. Nitrogen application</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>16. Insect resistant crops</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>17. Mechanical weeding</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>18. Reduced rates of herbicides</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>19. Reduced nitrogen fertilizer rates</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>20. Use of nitrification inhibitor</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>21. Reduced tillage</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>22. Use of green manure</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>23. Herbicide resistant crops</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>24. Crop rotation</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>25. Use of animal manure</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

(I=None; 2=Low Extent; 3=Moderate; 4=High; 5=Very High Extent)
4. Teaching methods

Indicate the extent to which you teach each selected sustainable agriculture topic in the agriculture curriculum by circling the appropriate number on a 5-point scale (1= None; 2= Low Extent; 3= Moderate; 4= High; 5= Very High Extent).

<table>
<thead>
<tr>
<th>Methods and Tools for teaching sustainable Agriculture</th>
<th>1= None; 2= Low Extent; 3= Moderate; 4= High; 5= Very High Extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Lectures</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>2. One-on-one instruction</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>3. Reading assignments</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>4. Case studies</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>5. Group Discussion</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>6. Demonstrations</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>7. Hands-on learning</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>8. Projects</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>9. Debates</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>10. Video tapes</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>11. Website</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>12. Workshops</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>13. Field days</td>
<td>1  2  3  4  5</td>
</tr>
</tbody>
</table>

(1=None; 2=Low Extent; 3=Moderate; 4=High; 5=Very High Extent)

5. Demographic information:

Write or circle your answer for each demographic question in the first column of table below in the corresponding box of the second column

<table>
<thead>
<tr>
<th>Demographic item</th>
<th>Write or circle your answer in this column</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Name of your state?</td>
<td>...........................................</td>
</tr>
<tr>
<td>2) What was (is) your undergraduate major?</td>
<td>a) Agronomy</td>
</tr>
<tr>
<td></td>
<td>b) Animal science</td>
</tr>
<tr>
<td></td>
<td>c) Horticulture</td>
</tr>
<tr>
<td></td>
<td>d) Agricultural education</td>
</tr>
<tr>
<td></td>
<td>e) Other....................................</td>
</tr>
<tr>
<td>3) What is your gender?</td>
<td>a) Male</td>
</tr>
<tr>
<td></td>
<td>2) Female</td>
</tr>
<tr>
<td>How many years have you taught agriculture?</td>
<td>...........................................</td>
</tr>
<tr>
<td>(write in the box)</td>
<td>Years</td>
</tr>
<tr>
<td>What is your higher level of education?</td>
<td>a. BS</td>
</tr>
<tr>
<td></td>
<td>b. M.S</td>
</tr>
<tr>
<td></td>
<td>c. PhD</td>
</tr>
<tr>
<td></td>
<td>d. other (specify).........................</td>
</tr>
</tbody>
</table>
Appendix C: Human Subject Approval
10/31/2016

Study Number: 2016E0649
Study Title: Agricultural high school teachers’ perception toward Sustainable Agriculture in Ohio State

Principal investigator: Melena Whittington
Date of determination: 10/31/2016

Qualifying exempt category: #2

Dear Melena Whittington,

The Office of Responsible Research Practices has determined the above referenced project exempt from IRB review.

Please note the following about this determination:

- Retain a copy of this correspondence for your records.
- Only the Ohio State staff and students named on the application are approved as Ohio State investigators and/or key personnel for this study.
- Simple changes to personnel that do not require changes to materials can be submitted for review and approval through Buck-IRB.
- No other changes may be made to exempt research (e.g., recruitment procedures, advertisements, instruments, protocol, etc.). If changes are needed, a new application for exemption must be submitted for review and approval prior to implementing the changes.
- Records relating to the research (including signed consent forms) must be retained and available for audit for at least 5 years after the study is closed. For more information, see university policies, Institutional Data and Research Data.
- It is the responsibility of the investigators to promptly report events that may represent unanticipated problems involving risks to subjects or others.

This determination is issued under The Ohio State University’s OHRP Federalwide Assurance #00006378. Human research protection program policies, procedures, and guidance can be found on the ORRP website.

Please feel free to contact the Office of Responsible Research Practices with any questions or concerns.

Jacob Stoddard
stoddard.13@osu.edu
(614) 292-0526