# PERCEPTIONS OF AGRICULTURE AND GEOGRAPHY STUDENTS AT TEXAS STATE UNIVERSITY TOWARDS SUSTAINABLE AGRICULTURE

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PERCEPTIONS OF AGRICULTURE AND GEOGRAPHY STUDENTS AT TEXAS

STATE UNIVERSITY TOWARDS SUSTAINABLE AGRICULTURE

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## ABSTRACT

PERCEPTIONS OF AGRICULTURE AND GEOGRAPHY STUDENTS AT TEXAS STATE UNIVERSITY TOWARDS SUSTAINABLE AGRICULTURE

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August 2011

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A study was conducted to determine the perceptions of agriculture and geography students at Texas State University-San Marcos towards sustainable agriculture. The study focused on students' self-assessed level of knowledge on selected sustainable agricultural practices. The objectives of the study were accomplished through a quantitative descriptive survey within Texas State. Likert-type scales were used to measure students' level of agreement with nine statements related to sustainable agriculture, their level of knowledge on selected sustainable farm practices, and the level of importance they place on the implementation of sustainable agriculture into college curricula. Data were collected using Qualtrics survey software following procedures by Dillman (2000). To account for reliability, a pilot test was conducted with a group of 16 students from the Department of Agriculture. The Cronbach alpha coefficients ranged between .84 and .94. A total of 500 students were invited to participate in the survey, out of which, 302 responded, for a 60.4 % response rate. Students rated themselves as having limited knowledge on some sustainable agriculture practices. The highest mean was ($M$ = 3.46) representing a range between *some knowledge* and *moderate knowledge* on the Likert-type scales used. Students had little knowledge on integrated pest management (IPM) as indicated by the lowest mean ($M$ = 2.57). Significant difference was noted between graduate and undergraduate students' level of knowledge on the topic, and also between undergraduates majoring in different fields. For instance Agricultural Education graduate students had the highest mean ($M$ = 3.73) for their level of knowledge on IPM. Analysis of variance (ANOVA) generated a significant difference ($p$ = .000) at ($p < .05$) level for IPM. Results from this study indicate a need for additional efforts from agricultural educators in incorporating sustainable agriculture courses into their curricula.

# CHAPTER I

## INTRODUCTION

The term sustainability has been defined by researchers in many different ways but all agree on its basic principle. Sustainability rests on the principle that we meet our present needs without compromising the ability of future generations to meet their own needs. Sustainable agriculture therefore defines a farming system that does not compromise or jeopardize the welfare and ability of future farmers to meet their farming needs. The importance of conserving the natural resources is the business of those practicing sustainable agriculture. The goal of this study was to determine the perceptions of agriculture and geography (resource and environmental studies) students at Texas State towards sustainable agriculture. Education systems should equip students with the knowledge of sustainable agriculture as a viable solution to the problem of resource depletion and environmental misuse. Unless this problem is addressed, our soil, water, and energy resources will be insufficient to maintain agricultural productivity very far into the future.

Limitations of the traditional agricultural curriculum may range from too much emphasis on the farm as the only business model and the teaching of agriculture solely as a vocational subject (Borsari, 2001). Agricultural education needs to address elements of emerging agriculture including sustainable production, processing, marketing, and distribution systems. Students should learn about farming systems that are economically profitable, environmentally sound, and socially acceptable.

The National Council for Agricultural Education in its 1988 mission statement, “Reinventing Agricultural Education for the Year 2020”, stressed the need to prepare high school and college students for successful careers and a lifetime of informed choices in the global agricultural industry, and natural resource management. Proper student preparation is important in enhancing the theme of sustainability. Curriculum materials should equip students with appropriate knowledge on how to utilize available resources to generate a lifetime stream of satisfaction.

The National Council for Science and Environment (2003) advanced the importance of the role of formal and non-formal education in helping to meet solutions to the challenges of environmental, social, and economic sustainability. Other studies also indicate that inclusion of sustainable agriculture into the agricultural curriculum can facilitate solutions to the current problems in agriculture, stimulate rural economic development, enrich scientific teaching of agriculture, and strengthen work skills for college students (Williams, 2000). Linking the real world with the classroom should be the concern of every curriculum developer. Increased interdisciplinary research projects and promotion of graduate and undergraduate programs on sustainable agriculture will increase student exposure in this important field of agriculture.

The main objectives of this study were to determine students’ perceptions, their level of knowledge on this topic, and the level of importance they place on implementation of sustainable agricultural practices into college curricula. The study was also meant to generate interest among agricultural educators to look at this farming practice from a more holistic perspective when developing their education curriculum.

**Purpose of the study**

The purpose of this study was to determine the perceptions of agriculture and geography (Resource and Environmental Studies) students at Texas State towards sustainable agriculture. The anticipated future role of students in the agricultural industry should guide every curriculum developer's effort. It is therefore important to understand students' perception, their level of knowledge, and the level of importance they place on topics related to sustainable agriculture.

Objectives of the study were:

1. To determine students' level of agreement with statements related to sustainable agriculture;
2. To determine students' level of knowledge on selected sustainable agriculture practices;
3. To determine differences in students' level of knowledge on selected sustainable agricultural practices based on their major;
4. To determine the level of importance that students place on the implementation of selected practices in undergraduate curriculum.

**Need for the study**

A needs assessment research was conducted on March 20, 2010 to determine the perception of Texas State undergraduate agriculture students towards sustainable agriculture. The first question asked students to choose the definition that best defines sustainable agriculture based on their understanding of the concept. The second question asked them to rate their level of knowledge on 10 selected sustainable farming practices. The third question asked the students to rate their level of agreement with the inclusion of

10 selected sustainable agriculture topics in undergraduate curriculum. Seventy seven percent of the respondents were positive about addition of more sustainable agriculture courses in the college undergraduate curriculum. Ninety three percent of the respondents strongly agreed that sustainable agriculture practices are useful in protecting the environment and conserving natural resources. Though the population studied was small, findings served the purpose of portraying students' interests in sustainable agriculture. This triggered the researcher's interest in the topic and the thought of expanding the population to include students from the Department of Geography.

**Definition of Terms**

Definitions of terms used were sourced from past related studies which included: Beus and Dunlap (1994), Gliessman (1998), Hillison (1996), National Research Council (1998), and Sanstone (2004). The core terms used in the study are: Agriscience, Agricultural Education Curriculum, conventional agriculture, perception, sustainable agriculture, and sustainable agricultural practices.

*Agriscience*: A comprehensive set of sciences that are normally used for learning, research, and practice in agriculture.

*Agricultural education curriculum:* A plan showing goals, objectives, time, and teaching methods for students in learning a specified content of subject matter in agriculture and food fiber.

*Conventional agriculture:* A type of farming system that depends heavily on capital intensive external inputs and institutions such as fossil fuels, agrochemicals, and credit institutions.

*Perception:* A personal view or judgment about a phenomenon, issue, activity, method or practice.

*Sustainable agriculture:* A system of agriculture in which food and fiber is produced using agricultural techniques and methods to conserve natural resources while ensuring a social, economic, and ecological continuity or improvements.

*Sustainable agricultural practices:* Farming practices that are socially desirable, environmentally sound, and economically viable.

# CHAPTER II

## LITERATURE REVIEW

Agricultural production systems that emphasize high yields have been remarkably effective in making United States one of the most productive nations in the whole world. Rapid advancements in agricultural technologies are the main factors behind this success. This impressive productivity may be offset, however, by over-dependence on pesticides and synthetic fertilizers, soil erosion, groundwater contamination, and food safety concerns (Williams, 1998). There has been much concern on food safety and the effects resulting from unsafe agricultural practices which pollute the environment, and deplete our natural resources: soil, water, forests, and wetlands. There is a growing awareness that agricultural systems must provide not only what humanity needs today, but what the human family will require a decade or even a century from now (Brady, 1990). The importance of conserving natural resources is therefore the business of every stakeholder in the agriculture industry.

Williams (2000) acknowledged the progress that agricultural educators at the national, State, and local levels have undertaken to provide sustainable agricultural education. According to Williams, agricultural educators have developed learning materials on the topic. Professional development programs have been conducted to disseminate curriculum materials and instructional aids and to strengthen teacher understanding of sustainable agriculture. Several years have now passed since the initial introduction of sustainable agriculture into most high school agricultural education curriculum.

An assessment of both high school and college students' perceptions is needed to guide further development of educational initiatives in this area. The goal is an education system that prepares high school and college students in agriscience, and promotes the study and application of sustainable agriculture for solutions to the problems of resource depletion and environmental misuse (Williams, 2000). Unless the problems of resource depletion and environmental misuse are resolved, our soil, water, and energy resources will be insufficient to maintain agricultural productivity very far into the future.

Borsari (2001) studied undergraduate agriculture curricula related to sustainability and found out some concepts which were difficult for U.S. students to understand. Biological pest control, rotational grazing, agro-ecosystem, and sustainable agriculture were among those concepts. For sustainable agriculture, the students had difficulty deciding what farming practices can become more sustainable, in what kind of environment, and in what social contexts. Borsari (2001) noted the difficulty and proposed that the complexity of this issue deserves much attention from every group of human society. There is therefore a need to improve curricula in the agricultural sciences to incorporate elements of sustainable agriculture that young agriculturists are not familiar with and enable them make sound decisions with scarce or limited resources. Sustainability deals with how to handle the scarce resources to provide a stream of satisfaction way long into the future.

Sustainable agriculture has been defined in different ways by agronomists, economists, and sociologists. Both agronomists and economists equate sustainable agriculture, respectively, with food sufficiency and efficient valued output per unit resource at the expense of the environment (Borsari & Vidrine, 2005). Ecologists and/or environmentalists value the maintenance of the natural resource base in food and fiber production. Sociologists emphasize promotion of desirable values and equitability in food and fiber production (Muma, 2006). Conroy (2000) defined sustainable agriculture as a system that tries to accommodate the basic needs of the present generation while preserving resources for future generations. The United States Department of Agriculture (USDA) is committed to working towards economic, environmental, and social sustainability of diverse food, fiber, forestry and range system. There seems to be a growing consensus that we need to spend less time trying to define sustainable agriculture and more time working to achieve it (NCSAREP, 2007).

Walter and Reisner (1994) found that agricultural researchers consider environmental management and development of new farming technologies as essential in defining sustainable agriculture. Their view of sustainability did not include social considerations, which on the other hand seem important for future agriculture. Apart from the environment, other critical factors determining the extent to which agriculture is sustainable are the degree of dependence on: labor, capital, technology, and role of gender (Muma, 2006). Sustainable agriculture therefore encompasses 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 is an interdisciplinary field of study that offers a potentially effective organizing structure with which to address many of the complex societal and environmental problems in the agri-food system that have heretofore been unapproachable by single disciplines (Francis et al., 2001).

**Curriculum and agricultural education research**

Since 1988, the Sustainable Agriculture Research and Education (SARE) program has helped advance farming systems that are profitable, environmentally sound and good for communities through a nationwide research and education grants program. The program is part of USDA's Cooperative State Research, Education, and Extension Service. It is managed in partnership with regional land grant hosts; funds projects and conducts outreach designed to improve agricultural systems.

The National Research Council (NRC) (1998) recommended expansion of the high school agricultural curriculum to include topics on sustainable agriculture. However, it was not until 1996 when the National Council for Agricultural Education (NCAE) (1996) distributed instructional materials nationally to assist in integrating sustainable agriculture into high school agricultural education curriculum. Some of the topics included in the new NCAE (1996) agriculture curriculum model were: soil and water conservation, land use, and air quality control. Muma (2006) acknowledged the steps taken by different States to integrate sustainable agriculture into high school and college curriculum. Not all States have taken the initiative to implement sustainable agriculture courses in their curriculum.

Santone (2004) proposed ways in which education systems may help students by infusing curriculum and instruction with concepts linking social, economic, and ecological systems. He believes that education systems should put a lot of emphasis on farming practices and how they affect the environment. This approach helps students understand the current and sustainable agricultural practices and the interactions of agricultural systems with the wider biological, physical, and social systems (Francis et al., 2001). A systems agricultural curriculum requires the design of learning environments and educational methods that emphasize active learning, inquiry-based learning, higher-order thinking, collaboration, and diversity (Muma, 2006).

The incorporation of principles or courses in sustainable agriculture, environmental science, policy, and holistic management, are provided when students enroll in graduate programs (Borsari and Vidrine, 2005). It therefore appears that it is at the graduate level that students become well grounded in education and are able to comprehend issues concerned with modern agriculture and its challenges from a more sustainable perspective. This limitation is unfortunate, as undergraduate students could achieve similar comprehension if provided with appropriate educational opportunities regarding the topic. Flanders (2008) proposed some initiatives that should be implemented to cultivate sustainable program in order for it to flourish in the future. The initiatives were:

- Sustainable agriculture courses should continue contributing to the total educational experience of the student at all levels.
- Colleges should cooperate with agriculture industry to boost awareness and literacy in sustainability.
- Expanded partnerships at national, state, and local levels with industry groups and organizations.
- Publicize the wide variety of rewarding careers available.

Walter and Reisner (1994) acknowledged the role of public educational programs in promoting the value and acceptance of sustainable production systems. Educational instruction programs based on sustainability can influence the knowledge, attitudes, and behavior of learners and lead them to greater environmental responsibility (Federico, Cloud, Byrne, and Wheeler, 2003). Williams and Wise (1997) argued that curriculum materials, instructional aids and innovative teaching approaches arising from developments in sustainable agriculture help students understand sustainable practices better. The processes in turn will facilitate student learning and curiosity in sustainable agriculture (Feldman, 1999). He further argued that including sustainable agriculture in school curriculum provides an opportunity for agricultural education to connect the applied sciences to the food and fiber system; thus an opportunity to enrich instruction with science and technology. Marshall and Herring (1991) believed that sustainable agriculture should be integrated into the curriculum. The integration of social sciences, production economics, and environmental sciences in a move towards sustainability improves agricultural curriculum.

The field of agriculture is adopting new farming techniques of: soil conservation, water conservation, wildlife protection, and production of safe and health food (Olson, 1997). Agricultural education system should be adjusted to accommodate teaching of emerging farming techniques which are geared towards sustainability. This study focused on students' level of knowledge on twelve sustainable agriculture practices: integrated pest management, rotational grazing, reduced use of herbicides and pesticides, animal manure as fertilizer, green manure, cover crops, reduced use of chemical fertilizers, conservation tillage, crop rotation, genetically modified crops, mixed farming, and farm recycling. Borsari (2001) noted that issues of environmental degradation and vulnerability of farming systems are raising societal concerns about conventional agriculture. He further argued that attention to economic aspects of agriculture cannot be neglected in designing any agricultural instruction curriculum. The sensitivity of the public about sustainable agriculture can be used as a strategy to address issues of environmental degradation and vulnerable farming systems in the revision of agricultural curricula (Borsari, 2001).

Jensen and Hauggaard-Nielsen (2004) explored the impacts of increased dependence on nitrogen fixing bacteria on plants and soils. Their argument was that decreased dependence on chemical fertilizers saves our ecosystem from harmful damage. Production and distribution of chemical nitrogen for use as agricultural fertilizer consumes between 1-2 percent of global fossil fuel. Though this direct contribution to energy use seems minimal, it is unnecessary and unsustainable. Excess nitrogen leaches into the ground water causing further environmental damage. This is an example of a negative externality associated with conventional agriculture. Both the pros and cons of different farming techniques need to be addressed fully in our curriculum.

Several studies addressing sustainable agriculture have been conducted. Most of these studies explored the level at which existing agricultural education programs address the topic and how teaching of sustainable agriculture by high school agriculture teachers and agricultural extension educators has been undertaken. Agbaje, Martin, and Williams (2001) studied the impacts of sustainable agriculture on secondary school agricultural education teaching and programs in North Central Region; Conroy, and Iqbal (2009) assessed the level of adoption of sustainability initiatives in Indiana, Kentucky, and Ohio;

O'Sullivan (2000) conducted an evaluation of sustainable agriculture training in North Carolina; Udoto and Flowers (2001); Williams (2000); Williams and Wise (1997).

The studies listed above agree with the idea that educational instruction programs based on sustainability influences the knowledge and attitudes of learners towards greater environmental responsibility. However, fewer studies have been conducted to determine perceptions and levels of knowledge of college and university students on sustainable agriculture. There is need therefore to undertake such studies at college and university levels in order to evaluate the performance and the impact of the existing sustainable agriculture curriculum.

Muma (2006) believes that negative attitudes towards sustainable agriculture among agricultural educators and teachers could be partly due to the fact that little has been done to incorporate courses of sustainability in agricultural curriculum. Constraints to teaching and learning sustainable agriculture are also caused by the ambiguity and lack of clarity of the meaning of sustainable agriculture (McIsaac, 1996). Agbaje et al. (2001) revealed that sustainable agriculture is taught from a systems perspective, using problem-solving and case study teaching approaches. It is therefore a more practical course which requires on-farm demonstrations to clearly illustrate the topic. From the review of literature, one reason that limits teaching and learning sustainable agriculture is the agricultural educators' perception and prior level of knowledge on the topic. Constraints that limit teacher access to curriculum materials and content knowledge for teaching sustainable agriculture can be addressed by the implementation of professional development programs for teachers. Some of the constraints experienced in the integration of sustainability topic into agricultural education include: lack of proven sustainable agriculture technologies from land-grant universities and lack of marketing potential sustainable careers (Conroy, 2000).

Parr, Trexler, Khanna, and Battisti (2007) agreed with the idea that students positively perceive the integration of sustainability topics in agricultural curriculum across the nation. Agriscience has components of traditional agriculture, environmental, and sustainable agriculture (Parr and Horn, 2006). Integration enhances collaboration in teaching among science and agriculture teachers, and promotes understanding among students (Conroy, 2000).

The need to solve increasingly complex problems regarding sustainability reinforces new forms of learning in problem solving which integrates disciplinary perspectives and insights (Muma, 2006). Cooperation by diverse academic experts and practitioners is called for in addressing sustainability. Such integrated forms of learning and research will then address both science's and society's diverse perceptions of the topic through communicative action, and work in order to produce practically relevant knowledge (Nikitina, 2006). The multiplicity of forms of such variations across disciplines and their organization into a coherent framework has become the focus of important theoretical contributions (Aram, 2004). This further implies that the paradigm of education has to be transformed as well to sustainable education.

The agriculture teachers' beliefs about the role of sustainable agriculture topics in meeting society's challenges and in the entire agricultural industry needs to be understood and promoted. Understanding the role of sustainable agriculture topics in the agriculture curriculum is possible when the needs of the teachers, students, and society regarding the agriculture industry are known. The relationship between teachers' beliefs about sustainable agriculture and inclusion of sustainable agriculture topics in the agriculture curriculum could be established in relation to constraints involved in accessing sustainable agriculture curriculum materials and teaching innovations (Conroy, 2000). Education systems should move away from socializations and vocational goals that take no account of the merits of sustainability.

To build an agricultural education curriculum that addresses the needs of agriculture students, it is important to understand the impact that sustainable agriculture philosophies can play in the curriculum (Udoto and Flowers, 2001). Diverse philosophies of agricultural teachers regarding sustainability can have great impact on how they motivate students to learn, and in how they develop curriculum content to achieve learning goals. Borsari (2001) recommended that innovative curriculum in sustainable agriculture must include several perspectives. One perspective is the awareness of broad socioeconomic and political issues which is also important for agricultural professionals, should be included in this new innovative curriculum. Borsari (2001) added that to become truly effective, a curriculum must be tailored to meet more societal needs and that participation of and motivation of students are necessary ingredients to implement appropriate curricula changes. A new curriculum may foster students' interest in holistic management of whole farming systems. The student will be equipped with information about managing land to balance natural resources, agricultural operations, profits and public responsibilities. This intellectual effort may also stimulate the community of agricultural educators by challenging their efforts and thoughts regarding a sustainable philosophy (Borsari, 2001).

Parr et al. (2007) explained different uses of experientially based teaching philosophy proposed for the farm. They compared and contrasted learning on the farm with learning in classrooms which rely on books. A resourceful learning should involve a lot of hands-on activities and not students acting as spectators. Parr et al. (2007) claimed, ‘‘if we study plowing in the classroom, we must also study it in the field... we must determine and test the relation of plowing to moisture, aeration, microbial life, and many other questions’’. For Parr et al. a farm must be made a true laboratory to collate and articulate with the theoretical instruction. Parr et al. (2007) proposed that students should learn by engaging in concrete field experiences, making observations and reflecting on the relationship of these discoveries to the more abstract disciplinary knowledge found in the classroom. This approach stood in sharp contrast to those who argued for memorization drills or simple vocational training. Sustainable farm practices like minimum and/or zero tillage should be clearly defined and if possible practical examples within school proximity used. Students should be allowed to tour farms practicing zero tillage to gain primary knowledge regarding the practice.

**Social reconstruction theory and sustainable agriculture curriculum**

An undergraduate sustainable agriculture program fits a social reconstruction theory (McNeil, 2006). Just like the way the theory places schools and education at the center of social, political, and economic development is what an undergraduate sustainable agriculture program does. The theory proposes that goals of any education system should include interests of individuals as well as those of the entire society as a whole. The most pressing societal needs should be the basis of curriculum development, teaching, learning, and evaluation. The theory assumes that all individual members of a society have the responsibility for the stewardship of all resources including natural resources and the entire societal institutions. The theory further argues that most curricula lack universal learning objectives and content because they prioritize contextual problems in educational processes. However, a common cycle that learning activities follow includes: problem analysis, learner and opportunity analysis, resource constraint analyses, linking issues to societal structures, linking situational analysis to ideal visions, and taking actions (McNeil, 2006). Institutions of higher education should move towards participatory and systemic learning for sustainable development which makes students appreciate, understand and think critically about complex environmental, social and economic problems.

Curricula in post-secondary academia has historically been discipline driven (classes and majors), pedagogically didactic (classroom lecture and drills), and focused on transmitting canons of formal knowledge (Aram, 2004). The invention of land-grant universities and colleges of agriculture in many ways challenged the order of these old-age academic traditions. Teachers should facilitate growth of knowledge by creating environments that allow students to engage in those activities that permit growth to take place. Parr and Horn (2006) placed emphasis on program areas concerned with teaching, extension, and research, and believed that they should:

1) Assist in developing and articulating the institutional philosophy, vision, mission, and goals for efforts addressing issues relating to sustainability of agricultural systems.
2) Ensure the integration of sustainable agricultural systems into the ongoing teaching, extension, and research programs.

3) Identify and implement strategies to enhance and increase collaborative work on sustainable agriculture across disciplines and departments with public and private sectors, organizations, businesses, and individual farmers.

Parr and Horn (2006) identifies activities on sustainable agriculture that have influenced most agricultural programs' efforts by fostering discussions and debates on issues related to long-term sustainability of food and agricultural systems, and facilitating both faculty and student-driven projects. He stated one measure of the influence of sustainable agriculture on our programs is the amount of competitive grants given to colleges of agriculture by the regional sustainable agriculture research and education programs.

As a problem-based study in universities, sustainability should unify attempts to explore and solve challenging problems that were previously isolated within broad disciplinary sectors (Sherren, 2007). Sustainable curriculum development is further encouraged by initiatives such as the Talloires Declaration on Education for Sustainable Development (ULSF, 1990) and the United Nations Decade of Education for Sustainable Development (2005–2014). Similar studies targeting students, farmers, extension agents, and teachers should be conducted nationwide to determine the general public level of knowledge and perception towards this very important topic. Interest will be triggered and individuals will double check their roles in the field of agriculture to confirm if they are sustainable.

# CHAPTER III

## METHODS AND PROCEDURES

### Design of the Survey

The purpose of this study was to determine the perceptions of agriculture and geography students at Texas State University towards sustainable agriculture. To accomplish this, questions were developed addressing the objectives of the study which were: (1) to determine students' extent of agreement with statements related to sustainable agriculture, (2) to determine students' level of knowledge on selected sustainable agricultural practices, (3) to determine the difference in students' level of knowledge on selected sustainable agricultural practices based on their majors, and (4) to determine the level of importance that students place on the implementation of the selected practices in undergraduate curriculum.

Qualtrics survey software was used in data collection. Qualtrics provided a platform for designing, distributing and evaluating survey results. The survey was split into two sections, the first section required students to provide their demographic information such as gender, college major, ethnicity, education classification, the area they grew up, age, and the source where they gained most exposure to sustainable agriculture. Several source options were provided for students to choose from. The options were classified based on different levels of education: high school, undergraduate and graduate levels. Graduate and undergraduate levels were further classified into different majors relative to student population studied. Independent variables in the study were gender, college major, age, the area where the student grew up and ethnicity.

The second part of the survey was comprised of questions in five-point (Likert-type) scale. The first question in this section asked students to rate their level of agreement with statements related to sustainable agriculture on the following Likert-type scales: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree. The statements were:

1. Sustainable agriculture production conserves natural resources.
2. Sustainable agriculture production allows farmers to sell products locally.
3. Sustainable agriculture production assures profitable returns from farm enterprise.
4. Sustainable agriculture production promotes long-term land productivity.
5. Sustainable agriculture production promotes the well-being of our ecosystem.
6. Courses in sustainable agriculture production should be included in all college curricula.
7. Sustainable agriculture production reduces ground water contamination.
8. Sustainable agriculture production promotes food safety.
9. Sustainable agriculture production benefits small-scale landowners/farmers.
10. Sustainable agriculture production increases farm income.

The second question asked the students to rate their level of knowledge on twelve sustainable agricultural practices on the following Likert-type scales: 1 = No Knowledge, 2 = Little Knowledge, 3 = Some Knowledge, 4 = Moderate Knowledge, 5 = High Knowledge. For the sake of data reporting and discussion numbering will be continued from the preceding questions:

11. Integrated pest management (combined pest-control practices).

12. Rotational grazing.
13. Reduced use of herbicides & pesticides.
14. Use of animal manure as fertilizer.
15. Use of green manure (cover crop plowed under).
16. Use of cover crops to prevent soil erosion.
17. Reduced use of chemical fertilizers.
18. Conservation tillage (e.g. no till farming).
19. Crop rotation.
20. Genetically modified crops.
21. Integrating plant crops with livestock enterprises.
22. Recycling agricultural wastes.

A question asking students to rate the level of importance they place on the implementation of the above sustainable agricultural practices in undergraduate curriculum marked the end of the survey. The items were scored on a five-point Likert-type scale where "1" indicated *unimportant*, "2" indicated *of little importance*, "3" indicated *somehow important*, "4" indicated *moderately important*, and "5" indicated *very important*.

**Research Design**

Descriptive research design was used in this study. Fraenkel and Wallen (2009) acknowledged the effectiveness of using descriptive studies in addressing research objectives. They both agreed that this design describes a given state of affairs as fully and as carefully as possible. Findings from this study provide very important information to researchers and educators regarding student perceptions on preferred learning/teaching in sustainable agriculture.

**Population**

Both graduate and undergraduate students enrolled in Agriculture and Geography Departments of Texas State were surveyed. An updated list containing names of students in the two departments was obtained through the assistance of the researcher's graduate advisor who was also the chair of the thesis committee. Purposive sampling was used to select students from the Department of Geography with only majors in Resource and Environmental Studies participating in the study. All graduate and undergraduate majors in the Department of Agriculture were surveyed. A pilot test was conducted with a group of 16 students from the Department of Agriculture. None of these 16 students were part of the sample. Email surveys were sent to a total of 500 students. Two hundred and nineteen were from Geography Department and 281 from the Agriculture Department.

**Instrumentation**

The survey instrument was developed based on literature review and suggestions from faculty members in the Department of Agriculture at Texas State. To establish face and content validity, the instrument was submitted to three faculty members for review of content. Based on the recommendations of the committee members, a number of revisions were made including changes to the wording of questions, and addition of definition of sustainable agriculture. The instrument measured students' perceived knowledge of 12 sustainable agriculture practices, the level of importance they place on the implementation of the 12 sustainable agricultural practices into the undergraduate curriculum, and students' perceptions on 10 general statements regarding sustainable agriculture.

To account for reliability, a pilot test was conducted with a group of 16 students from the department of agriculture. The response rate for the pilot test was 100%. The pilot test reported Cronbach alpha coefficients of $\alpha = .93$, $\alpha = .94$, and $\alpha = .84$ for the knowledge, importance and general statements, respectively.

**Data Collection**

Qualtrics survey software was used in data collection. Qualtrics provided a platform for designing and distributing surveys. Email surveys were sent on January 26, 2011 to a total of 500 students from the Departments of Agriculture and Geography; 281 and 219 respectively. The email contained an introduction from the researcher, an explanation of the survey, an invitation to participate, a drawing offer of $25 Walmart gift card for two lucky survey participants, and a link to the survey. A statement regarding the approval of the study by Texas State Institutional Review Board was also made on the cover page. Students were given a period of two weeks to complete and submit the survey.

By the end of two weeks, a total of 104 students had responded. The calculated response rate following the first email was 17.8%. On February 9, 2011, a reminder email was sent to students who had not responded, and to those who had started but did not finish the survey. One week was given for the two groups to complete the survey.

On February 17, 2011, student responses had totaled 147; an addition of 43 to the first round of email. A second reminder email was sent and the students asked to respond by February 24, 2011. One hundred and sixty five students had responded by February

24, 2011. Third and final reminder emails were sent on the 24th February, 2011. Two weeks following the final reminder 180 students had responded.

To improve the response rate, hard copies of the instrument were made and distributed to students who had not responded to the online survey. This exercise was made successful by cooperative faculty in the Department of Agriculture who asked students to volunteer and complete the survey within the first five minutes of their class time; just before lessons begun. After being granted permission by faculty to enter their classrooms, the researcher quickly distributed the surveys among students who had not completed the online survey. The instructors/faculty announced clearly to students that it was only those who had not completed the online survey that were required to fill the paper surveys. One hundred and twenty two surveys were received by the end of one week.

Data collected via Qualtrics were uploaded directly into an SPSS 13.0 data file. One hundred and twenty two paper surveys were entered manually to SPSS. A total of 302 of the 500 students responded, yielding an overall response rate of 60.4%.

**Data Analysis**

The results of the survey were reported using descriptive statistics: the overall response rate, means, standard deviations and frequencies for each question. Analysis of variance (ANOVA) was used to determine if the difference in means of students from different majors studied were statistically significant.

# CHAPTER IV

## FINDINGS AND DISCUSSION

The purpose of this study was to determine the perceptions of Agriculture and Resource and Environmental Studies students at Texas State towards sustainable agriculture. The first purpose was to determine students' level of agreement with statements related to sustainable agriculture. Second purpose was to determine students' level of knowledge on sustainable farm practices. Third question asked students to indicate the level of importance they place on the implementation of sustainable agricultural courses in undergraduate curriculum. Last but not least the study sought to determine difference in students' level of knowledge on the topic based on their major. To enhance comparisons among the student population studied, a demographic snapshot was deemed necessary. Independent variables which enhanced comparisons were: gender, major, ethnicity, area, and age.

Table 1 – Table 4 provide a snapshot of population composition based on gender, ethnicity, age, and college major. Of the 302 student respondents, 156 (51.7%) were male and 146 (48.3%) were female as shown in Table 1.

Table 1

*Participant Classification Based on Gender*

| **Gender** | ***n*** | **%** |
|---|---|---|
| Male | 156 | 51.7 |
| Female | 146 | 48.3 |
| Total | 302 | 100.0 |

The majority of student respondents were Caucasians representing 78% of the total student population as shown in Table 2.

Table 2

*Participant Classification Based on Ethnicity*

| **Ethnicity** | ***n*** | **%** |
|---|---|---|
| Caucasian/White | 236 | 78.1 |
| Hispanic | 42 | 13.9 |
| Other | 19 | 6.3 |
| African American | 5 | 1.0 |
| Total | 302 | 100.0 |

Table 3 shows that majority of respondents (50.7%) fall between the ages of 21-25 years old.

Table 3:

*Participant Classification Based on Age*

| **Age** | ***n*** | **%** |
|---|---|---|
| 20 and below | 85 | 28.1 |
| 21-25 | 153 | 50.7 |
| 26-30 | 37 | 12.3 |
| 31-36 | 16 | 5.3 |
| 36 and above | 11 | 3.6 |
| Total | 302 | 100.0 |

Descriptive statistics indicated that 75 respondents (24.8%) were Resource and Environmental Studies majors. This was the largest group of respondents compared with other majors. It was followed by majors in General Agriculture represented by 43 respondents (14.2%), Agribusiness majors were 40 (13.2%). Other respondents classified by their majors are shown in Table 4 appearing below. Information on student population composition enhanced comparisons on various themes that the study was addressing. For instance, in order to compare students' levels of knowledge on various sustainable agricultural practices, information on the target population composition was valuable.

Table 4

*Participant Classification Based on Majors*

| **Major** | ***n*** | **%** |
|---|---|---|
| Resource & Environmental studies-Undergraduate | 75 | 24.8 |
| General Agriculture | 43 | 14.2 |
| Agribusiness Management | 40 | 13.2 |
| Agribusiness Management Horticulture | 38 | 12.6 |
| Animal science | 35 | 11.6 |
| Animal Science – Pre Vet | 21 | 7.0 |
| General Agriculture with Teacher Certification | 20 | 6.6 |
| Agribusiness Management Ag Systems | 17 | 5.6 |
| Agricultural Education – Graduate | 12 | 4.0 |
| Resource & Environmental studies-Graduate | 1 | 0.3 |
| Total | 302 | 100.0 |

It was important to know the source where students got the most exposure to sustainable agriculture. Table 5 shows that 152 students representing 50.3% of the total student respondents chose undergraduate agriculture courses taken at Texas State as their major source of exposure to sustainable agriculture. Sixty seven out of the 75 student respondents majoring in Resource and Environmental studies chose undergraduate geography courses taken at Texas State as their major source of exposure to the topic. Only 35 (11.6%) of the total population chose high school as their major source of exposure. Other sources of exposure were accounted for in Table 5 below.

Table 5

*Participant Classification Based on Source of Most Exposure to Sustainable Agriculture*

| **Source** | ***n*** | **%** |
|---|---|---|
| Undergraduate Agriculture courses taken at this university | 152 | 50.3 |
| Undergraduate Geography Courses at this University | 67 | 22.2 |
| High school | 35 | 11.6 |
| Professional development | 18 | 6.0 |
| Graduate Agriculture courses taken at this university | 10 | 3.3 |
| Undergraduate Geography courses taken at a different university | 6 | 2.0 |
| Graduate Geography courses taken at this university | 1 | 0.3 |
| Other | 1 | 0.3 |
| Total | 302 | 100.0 |

**Findings related to objective #1 – assessing students' levels of agreement with statements related to sustainable agriculture**

Descriptive statistics were run on responses to the question asking students to rate their level of agreements with statements related to sustainable agriculture and results recorded in Table 6. The statement that sustainable agriculture production promotes the well-being of our ecosystem generated the highest mean score (*M* = 4.28). The statement that sustainable agriculture assures profitable returns from farm enterprises scored the lowest mean (*M* = 3.47). Means for other statements are shown in Table 6 below.

Table 6

*Overall Means for Students' Level of Agreement with Statements Related to Sustainable Agriculture*

| **Statement** | ***n*** | ***M**** | ***SD*** |
|---|---|---|---|
| Sustainable agriculture production promotes the well-being of our ecosystem | 276 | 4.28 | .84 |
| Sustainable agriculture production conserves natural resources | 276 | 4.27 | .80 |
| Sustainable agriculture promotes long-term land productivity | 276 | 4.25 | .84 |
| Sustainable agriculture allows farmers to sell products locally | 276 | 4.04 | .79 |
| Sustainable agriculture production promotes food safety | 276 | 4.03 | .87 |
| Sustainable agriculture production reduces ground water contamination | 276 | 3.99 | .90 |
| Sustainable agriculture production benefits small-scale farmers | 276 | 3.98 | .93 |
| Courses in sustainable agriculture production should be included in all college curricula | 276 | 3.92 | .98 |
| Sustainable agriculture production increases farm income | 276 | 3.49 | .87 |
| Sustainable agriculture production assures profitable returns from farm enterprises | 276 | 3.47 | .86 |

* Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

**Students' level of agreement with statements defining sustainable agriculture based on different college majors**

Students majoring in Resource and Environmental studies strongly agreed with the statement that sustainable agriculture conserves natural resources. They had a mean of (*M* = 4.55). Agricultural Education graduate students were second with mean (*M* = 4.45). Students majoring in Animal science – Pre Vet obtained the lowest mean (*M* = 3.95), as compared with other majors. Thirty one students majoring in animal science responded to this question. Their average mean was (*M* = 4.03) with a standard deviation of (*SD* = .80). Table 7 below summarizes the means for the perceptions of all the majors who responded to the question.

Table 7

*Sustainable Agriculture Conserves Natural Resources – Overall means of Students' Perceptions Based on Major*

| **Major** | ***n*** | ***M**** | ***SD*** |
|---|---|---|---|
| Resource and Environmental Studies – Undergraduate | 65 | 4.55 | .61 |
| Agricultural Education – Graduate | 11 | 4.45 | .69 |
| Agribusiness Management – Ag. Systems | 16 | 4.44 | .63 |
| Agribusiness Management – Horticulture | 38 | 4.37 | .82 |
| General Agriculture with teacher certification | 18 | 4.33 | .69 |
| Agribusiness Management | 36 | 4.17 | .81 |
| Animal Science | 31 | 4.03 | .80 |
| General Agriculture | 40 | 3.98 | .92 |
| Animal science – Pre vet | 20 | 3.95 | .99 |

* Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Table 8 reports means and standard deviations of students' level of agreement with the statement that sustainable agriculture production allows farmers to sell produce locally. Means for students majoring in Agribusiness Management-Ag Systems were the highest (*M* = 4.25); followed closely by Agribusiness Management-Horticulture (*M* = 4.24). Generally students' level of agreement with this statement was high as indicated by the mean scores which ranged between 3.75 and 4.25. The mean obtained by other majors is shown in the table below.

Table 8

*Sustainable Agriculture Allows Farmers to Sell Products Locally – Overall Means of Students' Perceptions Based on Major*

| **Major** | ***n*** | ***M**** | ***SD*** |
|---|---|---|---|
| Agribusiness Management – Ag. Systems | 16 | 4.25 | .68 |
| Agribusiness Management – Horticulture | 38 | 4.24 | .75 |
| Resource and Environmental Studies – Undergraduate | 65 | 4.20 | .81 |
| Agricultural Education – Graduate | 11 | 4.09 | .83 |
| Animal Science | 31 | 4.03 | .66 |
| Animal science – Pre vet | 20 | 4.00 | 1.03 |
| General Agriculture with Teacher Certification | 18 | 3.89 | .58 |
| Agribusiness Management | 36 | 3.83 | .66 |
| General Agriculture | 40 | 3.75 | .90 |

* Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Overall means for question 3 ranged between (*M* = 3.69) and (*M* = 3.25) as it appears on Table 9. Responses from Agribusiness Management – Ag Systems recorded the highest mean followed by majors in General Agriculture with Teacher Certification (*M* = 3.61). Agribusiness majors obtained the lowest mean (*M* = 3.25) as compared to other majors. Table 9 illustrates mean scores for the statement that sustainable agriculture production assures profitable returns from farming enterprises for all the majors studied.

Table 9

*Sustainable Agriculture Production Assures Profitable Returns from Farm Enterprises – Overall Means of Students' Perceptions Based on Major*

| **Major** | ***n*** | ***M**** | ***SD*** |
|---|---|---|---|
| Agribusiness Management – Ag. Systems | 16 | 3.69 | .70 |
| General Agriculture with Teacher Certification | 18 | 3.61 | .70 |
| Animal science – Pre vet | 20 | 3.60 | .94 |
| Animal Science | 31 | 3.55 | .89 |
| Resource and Environmental Studies – Undergraduate | 65 | 3.52 | .85 |
| Agribusiness Management – Horticulture | 38 | 3.50 | .86 |
| Agricultural Education – Graduate | 11 | 3.45 | .69 |
| General Agriculture | 40 | 3.30 | .85 |
| Agribusiness Management | 36 | 3.25 | .99 |

* Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Question 4 determined students' level of agreement with the statement that sustainable agriculture production promotes long-term land productivity. Compared to other questions, means generated for this question were high; Resource and Environmental Studies students scored the highest mean (*M* = 4.60) followed by majors in Agribusiness Management (*M* = 4.42). Although the lowest mean for this question (*M* = 3.93) was recorded by general agriculture majors, it still represented some level of agreement with the statement in question.  Means obtained by all the groups studied are presented in Table 10 below.

Table 10

*Sustainable Agriculture Production Promotes Long Term Land Productivity – Overall Means of Students' Perceptions Based on Major*

| **Major** | ***n*** | ***M**** | ***SD*** |
|---|---|---|---|
| Resource and Environmental Studies – Undergraduate | 65 | 4.60 | .70 |
| Agribusiness Management – Horticulture | 38 | 4.42 | .95 |
| Agribusiness Management – Ag. Systems | 16 | 4.38 | .62 |
| Agribusiness Management | 36 | 4.22 | .54 |
| Agricultural Education – Graduate | 11 | 4.18 | .87 |
| General Agriculture with Teacher Certification | 18 | 4.17 | .62 |
| Animal science – Pre vet | 20 | 4.00 | 1.08 |
| Animal Science | 31 | 3.94 | .85 |
| General Agriculture | 40 | 3.93 | .97 |

* Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Question 5 asked students to indicate their extent of agreement with the statement that sustainable agriculture production promotes the wellbeing of the ecosystem. The mean was computed based on college majors and results recorded in Table 11. Students majoring in Resource and Environmental Studies obtained the highest mean ($M$ = 4.55) followed by Agribusiness Management – Horticulture majors ($M$ = 4.53). Animal Science majors recorded the lowest mean ($M$ = 3.90) among the groups studied. Mean results for other majors were reported on Table 11 below.

Table 11

*Sustainable Agriculture Production Promotes the Wellbeing of our Ecosystem – Overall Means of Students' Perceptions Based on Major*

| **Major** | ***n*** | ***M**** | ***SD*** |
|---|---|---|---|
| Resource and Environmental Studies – Undergraduate | 65 | 4.55 | .69 |
| Agribusiness Management – Horticulture | 38 | 4.53 | .83 |
| Agribusiness Management – Ag. Systems | 16 | 4.38 | .62 |
| Agricultural Education – Graduate | 11 | 4.36 | .67 |
| Agribusiness Management | 36 | 4.31 | .71 |
| General Agriculture with Teacher Certification | 18 | 4.11 | .83 |
| General Agriculture | 40 | 4.00 | .99 |
| Animal Science – Pre vet | 20 | 4.00 | 1.03 |
| Animal Science | 31 | 3.90 | .83 |

* Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Question 6 asked students to rate their level of agreement about the inclusion of sustainable agriculture courses in college curricula. Agricultural Education graduate students generated the highest mean (*M* = 4.45), General Agriculture with Teacher Certification (*M* = 4.28), Agribusiness management-Horticulture (*M* = 4.26), Resource and Environmental Studies (*M* = 3.97), Agribusiness Management-Ag. Systems (*M* = 3.88), Agribusiness Management (*M* = 3.86), Animal Science (*M* = 3.71), General Agriculture (*M* = 3.63), and Animal science-Pre Vet (*M* = 3.60). Table 12 provides a summary of the above results.

Table 12

*Overall Means for Student Perceptions on the Inclusion of Sustainable Agriculture Courses in College Curricula – Based on Major*

| **Major** | ***n*** | ***M**** | ***SD*** |
|---|---|---|---|
| Agricultural Education – Graduate | 11 | 4.45 | .82 |
| General Agriculture with Teacher Certification | 18 | 4.28 | .75 |
| Agribusiness Management – Horticulture | 38 | 4.26 | .92 |
| Resource and Environmental Studies – Undergraduate | 65 | 3.97 | 1.00 |
| Agribusiness Management – Ag. Systems | 16 | 3.88 | .86 |
| Agribusiness Management | 36 | 3.86 | .87 |
| Animal Science | 31 | 3.71 | 1.07 |
| General Agriculture | 40 | 3.63 | 1.03 |
| Animal Science – Pre vet | 20 | 3.60 | 1.05 |

* Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Question 7 asked students to rate the extent they agree with the statement that sustainable agriculture production reduces ground water contamination. Resource and Environmental Studies had the highest mean (*M* = 4.35) followed by Agricultural Education graduate students (*M* = 4.18), Agribusiness Management – Horticulture (M = 4.16).and general agriculture (*M* = 3.68). Of all the college majors studied Resource and Environmental Studies had the highest mean which indicated that they were in strong agreement with the statement as compared with other majors. Table 13 illustrates overall means of all majors studied.

Table 13

*Sustainable Agriculture Reduces Ground Water Contamination – Overall Means of Students' Perceptions Based on Major*

| **Major** | ***n*** | ***M**** | ***SD*** |
|---|---|---|---|
| Resource and Environmental Studies – Undergraduate | 65 | 4.35 | .89 |
| Agricultural Education – Graduate | 11 | 4.18 | .75 |
| Agribusiness Management – Horticulture | 38 | 4.16 | .86 |
| General Agriculture with Teacher Certification | 18 | 4.00 | .69 |
| Agribusiness Management | 36 | 3.97 | .69 |
| Animal Science – Pre vet | 20 | 3.80 | 1.00 |
| General Agriculture | 40 | 3.68 | .92 |
| Agribusiness Management – Ag. Systems | 16 | 3.63 | .96 |
| Animal Science | 31 | 3.61 | .96 |

* Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Table 14 illustrates that Agribusiness Management – Horticulture students strongly believed that sustainable agriculture practices promote food safety ($M$ = 4.37). They were followed closely by undergraduate students majoring in Resource and Environmental Studies ($M$ = 4.25); Agribusiness Management – Ag. Systems ($M$ = 4.13). Animal Science – Pre Vet students obtained the lowest mean ($M$ = 3.65). Overall means obtained by students in different majors were recorded in Table 14 below.

Table 14

*Sustainable Agriculture Production Promotes Food Safety – Overall Means for Students' Perceptions Based on Major*

| **Major** | ***n*** | ***M**** | ***SD*** |
|---|---|---|---|
| Agribusiness Management – Horticulture | 38 | 4.37 | .71 |
| Resource and Environmental Studies – Undergraduate | 65 | 4.25 | .90 |
| Agribusiness Management – Ag. Systems | 16 | 4.13 | .62 |
| Agricultural Education – Graduate | 11 | 4.00 | 1.00 |
| General Agriculture with Teacher Certification | 18 | 4.00 | .67 |
| Agribusiness Management | 36 | 3.92 | .73 |
| Animal Science | 31 | 3.87 | .85 |
| General Agriculture | 40 | 3.70 | .99 |
| Animal Science – Pre vet | 20 | 3.65 | .93 |

* Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Overall means for students' perception on the statement that sustainable agriculture production benefits small scale landowners were determined and results recorded on Table 15. Agricultural Education graduate students had the highest mean as compared to other majors ($M$ = 4.55). Resource and Environmental Studies students had a mean of ($M$ = 4.25); second highest mean. The lowest mean was obtained by Animal Science-Pre Vet majors ($M$ = 3.65). The highest mean obtained by Agricultural Education graduate students indicated that they are more knowledgeable on how sustainable agriculture could benefit small scale farmers. Sustainable farm practices enhance continuous productivity of farm resources.

Table 15

*Sustainable Agriculture Production Benefits Small-Scale Landowners – Overall Means for Students' Perceptions Based on Major*

| **Major** | ***n*** | ***M**** | ***SD*** |
|---|---|---|---|
| Agricultural Education – Graduate | 11 | 4.55 | .52 |
| Resource and Environmental Studies – Undergraduate | 65 | 4.25 | .88 |
| Agribusiness Management – Ag. Systems | 16 | 4.13 | .62 |
| Agribusiness Management – Horticulture | 38 | 4.11 | 1.01 |
| General Agriculture with Teacher Certification | 18 | 4.00 | .69 |
| Agribusiness Management | 36 | 3.89 | .95 |
| Animal Science | 31 | 3.71 | 1.01 |
| General Agriculture | 40 | 3.68 | .94 |
| Animal Science – Pre vet | 20 | 3.65 | 1.04 |

* Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Students were asked to rate their level of agreement with the statement that sustainable agriculture production increases farm income. The question measured students' understanding of the benefits of sustainable agricultural systems which generate a continuous flow of returns from available set of resources. Responses to this question generated a low mean score indicating that students were neutral; neither in strong agreement with the statement nor in strong disagreement. The highest mean obtained was ($M$ = 3.72) by students majoring in General Agriculture with Teacher Certification and the least was by Agribusiness majors with a mean of ($M$ = 3.25). Table 16 indicates the mean obtained by other majors.

Table 16

*Sustainable Agriculture Production Increases Farm Income – Overall Means for Students' Perceptions Based on Major*

| **Major** | ***n*** | ***M*** * | ***SD*** |
|---|---|---|---|
| General Agriculture with Teacher Certification | 18 | 3.72 | .67 |
| Agricultural Education – Graduate | 11 | 3.64 | .81 |
| Animal Science | 31 | 3.61 | .86 |
| Agribusiness Management – Horticulture | 38 | 3.61 | .95 |
| Resource and Environmental Studies – Undergraduate | 65 | 3.52 | .92 |
| Animal Science – Pre vet | 20 | 3.45 | .95 |
| Agribusiness Management – Ag. Systems | 16 | 3.38 | .50 |
| General Agriculture | 40 | 3.33 | .86 |
| Agribusiness Management | 36 | 3.25 | 1.00 |

* Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

**Findings related to objective #2 – assessing students' level of knowledge on the topic**

Descriptive statistics were run to determine students' level of knowledge on twelve sustainable agriculture practices. Means obtained indicated that Texas State students who participated in the survey were moderately knowledgeable on the selected sustainable agricultural practices. The overall means for the practices ranged between ($M$ = 2.57) and ($M$ = 3.46) which on Likert-type scale represented a range between little knowledge and moderate knowledge. Use of animal manure as fertilizer had the highest mean ($M$ = 3.46) while integrated pest management (IPM) generated the lowest mean ($M$ = 2.57). Student knowledge on other sustainable farm practices was measured and results recorded in Tables 17 and 18.

Table 17

*Overall Means for Students' Level of Knowledge on Selected Sustainable Agricultural Practices*

| **Practice** | ***n*** | ***M**** | ***SD*** |
|---|---|---|---|
| Use of animal manure as fertilizer | 276 | 3.46 | 1.04 |
| Crop rotation | 276 | 3.36 | 1.15 |
| Reduced use of chemical fertilizers | 276 | 3.17 | 1.15 |
| Genetically modified crops | 276 | 3.17 | 1.18 |
| Use of cover crops to prevent soil erosion | 276 | 3.15 | 1.20 |
| Reduced use of herbicides & pesticides | 276 | 3.09 | 1.11 |
| Rotational grazing | 276 | 3.04 | 1.23 |
| Recycling agricultural wastes | 275 | 2.92 | 1.22 |
| Use of green manure (cover crop plowed under) | 276 | 2.70 | 1.24 |
| Conservation tillage (e.g. no till farming) | 276 | 2.66 | 1.22 |
| Integrating plant crops with livestock enterprises | 275 | 2.63 | 1.19 |
| Integrated pest management | 276 | 2.57 | 1.14 |

*Scale: 1=No Knowledge, 2=Little Knowledge, 3=Some Knowledge, 4=Moderate Knowledge, 5=High knowledge

Table 18 indicates the distribution of respondents based on their level of knowledge on different sustainable farm practices; lowest scale "1" for *No Knowledge* and highest scale "5" for *High Knowledge.* Of the 276 students 19, (6.3%) chose high knowledge, 38, (12.6%) moderate knowledge, 76 (25.2%) some knowledge, 92 (30.5%) little knowledge, and 51 (16.9%) chose no knowledge for IPM. Different knowledge levels of students on other practices are shown in Table 18 below.

Table 18

*Percentage Distribution of Students' Level of Knowledge on Sustainable Agriculture on Different Scales of Measurement*

| | **No Knowledge** | | **Little Knowledge** | | **Some Knowledge** | | **Moderate Knowledge** | | **High knowledge** | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Practice** | ***n*** | **%** | ***n*** | **%** | **n** | **%** | ***n*** | **%** | ***n*** | **%** |
| Integrated pest management | 51 | 16.9 | 92 | 30.5 | 76 | 25.2 | 38 | 12.6 | 19 | 6.3 |
| Rotational grazing | 42 | 13.9 | 46 | 15.2 | 78 | 25.8 | 79 | 26.2 | 31 | 10.3 |
| Reduced use of herbicides & pesticides | 19 | 6.3 | 67 | 22.2 | 94 | 31.1 | 61 | 20.2 | 35 | 11.6 |
| Animal manure as fertilizer | 13 | 4.3 | 29 | 9.6 | 97 | 32.1 | 91 | 30.1 | 46 | 15.2 |
| Use of green manure | 60 | 19.9 | 61 | 20.2 | 80 | 26.5 | 51 | 16.9 | 24 | 7.9 |
| Use of cover crops to prevent soil erosion | 29 | 9.6 | 55 | 18.2 | 76 | 25.2 | 78 | 25.8 | 38 | 12.6 |
| Reduced use of chemical fertilizers | 23 | 7.6 | 52 | 17.2 | 95 | 31.5 | 66 | 21.9 | 40 | 13.2 |
| Conservation tillage | 58 | 19.2 | 71 | 23.5 | 76 | 25.2 | 49 | 16.2 | 22 | 7.3 |
| Crop rotation | 20 | 6.6 | 44 | 14.6 | 74 | 24.5 | 93 | 30.8 | 45 | 14.9 |
| Genetically modified crops | 28 | 9.3 | 51 | 16.9 | 79 | 26.2 | 82 | 27.2 | 36 | 11.9 |
| Integrating plant crops with livestock enterprises | 53 | 17.5 | 82 | 27.2 | 75 | 24.8 | 43 | 14.2 | 22 | 7.3 |
| Recycling agricultural wastes | 34 | 11.3 | 82 | 27.2 | 62 | 20.5 | 65 | 21.5 | 32 | 10.6 |

**Findings related to objective #3 – Analysis of variance in students' level of knowledge based on majors**

Questions addressing objective #2 sought to determine students' level of knowledge on the following sustainable agricultural practices: Integrated pest management, rotational grazing, reduced use of herbicides and pesticides, use of animal manure as fertilizer, use of green manure (cover crop plowed under), use of cover crops to prevent soil erosion, reduced use of chemical fertilizers, conservation tillage (e.g. no till farming), crop rotation, genetically modified crops, and recycling of agricultural wastes. Analysis of variance in students' level of knowledge on integrated pest management was measured based on majors.

Means generated were recorded in Table 19. Agricultural Education graduate students obtained the highest mean ($M$ = 3.73) followed by undergraduate students majoring in Agribusiness Management-Horticulture ($M$ = 3.32). The least mean was recorded by Animal Science majors ($M$ = 1.77). There was a significant difference in means ($p$ = .000) at ($p < .05$) level as indicated on Table 19. The range between the highest mean ($M$ = 3.73) and the lowest ($M$ = 1.77) represented the range of *no knowledge* to *moderate knowledge* on Likert-type scale used. It therefore appears that it is at the graduate level that students become more knowledgeable on the topic and are thus able to comprehend issues concerned with modern agriculture from a more sustainable perspective.

Table 19

*ANOVA for question 11 (Level of Knowledge on Integrated Pest Management Practices) Based on Majors*

| **Major** | ***n*** | ***M*** | ***SD*** | ***df*** | **F** | ***p*** |
|---|---|---|---|---|---|---|
| Agricultural Education – Graduate | 11 | 3.73 | 1.10 | 8 | 7.79 | .000* |
| Agribusiness Management – Horticulture | 38 | 3.32 | 1.07 | | | |
| General Agriculture with Teacher Certification | 18 | 2.94 | 1.26 | | | |
| General Agriculture | 40 | 2.68 | 1.21 | | | |
| Agribusiness Management | 36 | 2.61 | .96 | | | |
| Agribusiness Management – Ag. Systems | 16 | 2.44 | .89 | | | |
| Resource and Environmental Studies – Undergraduate | 65 | 2.32 | .90 | | | |
| Animal science – Pre vet | 20 | 2.05 | 1.40 | | | |
| Animal Science | 31 | 1.77 | .81 | | | |

***Significant at the p < 0.05 level**
***M*** = Scale: 1=No Knowledge, 2=Little Knowledge, 3=Some Knowledge, 4=Moderate Knowledge, 5=High knowledge

Animal Science majors were significantly different from the following majors: General Agriculture, General Agriculture with Teacher Certification, Agribusiness Management, Agribusiness Management-Horticulture, and Agricultural Education graduate students at significance level ($p < 0.05$). Figures marked with an asterisk in Table 20 represent mean differences that are significant at level ($p < 0.05$). Student respondents majoring in Animal Science had the lowest mean when compared with other majors. At this point it is possible to infer that Animal Science students are not exposed to the topic of IPM as much as students in other majors do.  Agricultural Education graduate students were highly knowledgeable on integrated pest management practice than undergraduate students. Possible conclusion could be that at graduate school students learn more about the topic than before (when they were pursuing their undergraduate degrees).

Table 20

*Mean Difference of Students Levels of Knowledge on Integrated Pest Management Practices (Tukey's HSD Test) Based on Majors*

| | **Ansc** | **AnscPv** | **GenAg** | **GenAgT** | **Agbm** | **AgbmH** | **AgbmAs** | **REnst** | **AgedG** |
|---|---|---|---|---|---|---|---|---|---|
| Ansc | - | -.28 | -.90* | -1.17* | -.84* | -1.54* | -.66 | -.55 | -1.95* |
| AnscPv | .28 | - | -.63 | -.89 | -.56 | -1.23* | -.38 | -.27 | -1.68* |
| GenAg | .90 | .63 | - | -.27 | .06 | -.64 | .24 | .35 | -1.05 |
| GenAgT | 1.17 | .89 | .27 | - | .33 | -.37 | .51 | .62 | -.78 |
| Agbm | .84* | .56 | .06 | -.33 | - | -.71 | -.17 | .29 | -1.12 |
| AgbmH | 1.54* | 1.27* | .64 | .37 | .71 | - | .88 | .99* | -.44 |
| AgbmAs | .66 | .39 | -.24 | -.51 | -.17 | -.88 | - | 1.11 | -1.29* |
| REnst | .55 | .27 | -.35 | -.62 | -.29 | -.99* | -1.11 | - | -1.40* |
| AgedG | 1.95 | 1.68* | 1.05 | .78 | 1.16 | .41 | 1.29* | 1.40* | - |

*Statistically significant at the $p < 0.05$ level

[z]Mean differences are calculated as group in the row minus the group in the column

Ansc – Animal Science

AnscPv – Animal Science Pre-Vet

GenAg – General Agriculture

GenAgT – General Agriculture with Teacher Certification

Agbm – Agribusiness Management

AgbmH – Agribusiness Management-Horticulture

AgbmAs – Agribusiness Management-Ag Systems

REnst – Resource and Environmental Studies

AgedG – Agricultural Education-Graduate

Question 12 asked the students to rate their level of knowledge on rotational grazing as a sustainable agricultural practice. Agricultural Education graduate students had the highest mean (*M* = 3.91), followed by majors in General Agriculture with Teacher Certification (*M* = 3.89). Means from other majors were recorded in Table 21.

Table 21

*ANOVA for question 12 (Level of Knowledge on Rotational Grazing) Based on Majors*

| **Major** | ***n*** | ***M*** | ***SD*** | ***df*** | ***F*** | ***p*** |
|---|---|---|---|---|---|---|
| Agricultural Education – Graduate | 11 | 3.91 | .94 | 8 | 2.8 | .005* |
| General Agriculture with Teacher Certification | 18 | 3.89 | .96 | | | |
| Agribusiness Management – Ag. Systems | 16 | 3.13 | 1.26 | | | |
| Resource and Environmental Studies – Undergraduate | 65 | 3.11 | 1.05 | | | |
| Agribusiness Management | 36 | 3.11 | 1.14 | | | |
| Animal Science | 31 | 2.94 | 1.29 | | | |
| General Agriculture | 40 | 2.80 | 1.45 | | | |
| Agribusiness Management – Horticulture | 38 | 2.68 | 1.14 | | | |
| Animal science – Pre Vet | 20 | 2.65 | 1.42 | | | |

*** Significant at the $p < 0.05$ level**

Post Hoc test (Tukey HSD) further indicated significant differences between different majors. Values in Table 22 marked by an asterisk represent groups/majors with statistically significant mean difference and it represents the following groups: Animal Science-Pre Vet students and majors in General Agriculture with Teacher Certification; General Agriculture and General Agriculture with Teacher Certification; General Agriculture with Teacher Certification majors and Agribusiness Management-

Horticulture students. Table 22 illustrates the results from Post Hoc test (Tukey HSD) for all the majors studied.

Table 22

*Mean Difference of Students Levels of Knowledge on Rotational Grazing (Tukey's HSD) Based on Majors*

| | **Ansc** | **AnscPv** | **GenAg** | **GenAgT** | **Agbm** | **AgbmH** | **AgbmAs** | **REnst** | **AgedG** |
|---|---|---|---|---|---|---|---|---|---|
| Ansc | - | .29 | .14 | -.95 | -.18 | .25 | -.19 | -.17 | -.97 |
| AnscPv | -.29 | - | -.15 | -1.24* | -.46 | -.03 | -.48 | -.46 | -1.26 |
| GenAg | -.14 | .15 | - | -1.09* | -.31 | .12 | -.33 | -.31 | -1.11 |
| GenAgT | .95 | 1.24* | 1.09* | - | .78 | 1.21* | .76 | .78 | -.02 |
| Agbm | .18 | .46 | .31 | -.78 | - | .43 | -.01 | .00 | -.80 |
| AgbmH | -.25 | .03 | -.12 | -1.21* | -.43 | - | -.44 | -.42 | -1.23 |
| AgbmAs | .19 | .48 | .33 | -.76 | .01 | .44 | - | .02 | -.78 |
| REnst | .17 | .46 | .31 | -.78 | -.00 | .42 | -.02 | - | -.80 |
| AgedG | .97 | 1.26 | 1.11 | .02 | .80 | 1.23 | .78 | .80 | - |

*Statistically significant at the $p < 0.05$ level
[z]Mean differences are calculated as group in the row minus the group in the column

Question 13 asked students to rate their level of knowledge on reduced use of herbicides and pesticides as a sustainable farming practice. Agricultural Education graduate students generated the highest mean ($M = 4.00$) followed by students majoring in Agribusiness Management-Horticulture ($M = 3.45$). The lowest mean was ($M = 2.58$) for Animal Science students. The levels of knowledge for students majoring in animal science have so far been low for practices associated with crop farming.

Table 23 indicates results obtained from analysis of variance in responses measuring students' level of knowledge in reduced use of herbicides and pesticides.

Table 23

*ANOVA for question 13 (Level of Knowledge on Reduced Use of Herbicides and Pesticides) Based on Majors*

| **Major** | ***n*** | ***M*** | ***SD*** | ***df*** | ***F*** | ***p*** |
|---|---|---|---|---|---|---|
| Agricultural Education – Graduate | 11 | 4.00 | .63 | 8 | 3.4 | .001* |
| Agribusiness Management – Horticulture | 38 | 3.45 | 1.08 | | | |
| Resource and Environmental Studies – Undergraduate | 65 | 3.34 | 1.08 | | | |
| General Agriculture with Teacher Certification | 18 | 3.11 | 1.37 | | | |
| Agribusiness Management – Ag. Systems | 16 | 2.94 | 1.00 | | | |
| General Agriculture | 40 | 2.93 | 1.21 | | | |
| Agribusiness Management | 36 | 2.83 | .91 | | | |
| Animal Science – Pre vet | 20 | 2.80 | 1.24 | | | |
| Animal Science | 31 | 2.58 | .92 | | | |

*** Significant at the $p < 0.05$ level**

Significant difference in mean existed between Animal Science and Agribusiness Management-Horticulture students at significance level ($p = 0.05$). There was also a significant difference in means between the following students: Agricultural Education graduate students and Animal Science undergraduate students; Agricultural Education graduate students and Agribusiness Management students at significance level ($p < 0.05$). Table 24 provides the Post Hoc (Tukey HSD) test results explained above. Values marked by an asterisk indicate difference in means which are statistically significant at ($p < 0.05$).

Table 24

*Mean Difference of Students Levels of Knowledge on Reduced Use of Herbicides and Pesticides (Tukey's HSD) Based on Majors*

| | **Ansc** | **AnscPv** | **GenAg** | **GenAgT** | **Agbm** | **AgbmH** | **AgbmAs** | **REnst** | **AgedG** |
|---|---|---|---|---|---|---|---|---|---|
| Ansc | - | .22 | -.34 | -.53 | -.25 | -.87* | -.36 | -.76 | -1.42* |
| AnscPv | .22 | - | -.13 | -.31 | -.03 | -.65 | -.14 | -.54 | -1.20 |
| GenAg | .34 | .13 | - | -.19 | .09 | -.52 | -.01 | -.41 | -1.08 |
| GenAgT | .53 | .31 | .19 | - | .28 | -.34 | .17 | -.23 | -.89 |
| Agbm | .25 | .03 | -.09 | -.28 | - | -.61 | -.10 | -.50 | -1.18* |
| AgbmH | .87 | .65 | .52 | .34 | .61 | - | .51 | .11 | -.55 |
| AgbmAs | .36 | .14 | .01 | -.17 | .10 | -.51 | - | -.40 | -1.06 |
| REnst | .76 | .54 | .41 | .23 | .51 | -.11 | .40 | - | -.66 |
| AgedG | 1.42 | 1.20 | 1.08 | .89 | 1.17* | .55 | 1.06 | .66 | - |

*Statistically significant at the $p < 0.05$ level

$^{z}$Mean differences are calculated as group in the row minus the group in the column

Question 14 tested students' level of knowledge on use of animal manure as a fertilizer in practicing sustainable agriculture. Most traditional farming techniques have been neglected for conventional farming methods. Conventional agriculture relies heavily on capital intensive inputs such as fossil fuels and agrochemicals which harm the environment. On the other hand sustainable agriculture promotes the use of environment friendly production techniques such as livestock manure in order to minimize the rate of soil contamination by chemicals in alternative inorganic fertilizers. The highest mean generated was (*M* = 4.00) by Agricultural Education graduate students followed by undergraduate majors in General Agriculture with Teacher Certification (*M* = 3.94). Means of other majors studied were recorded in Table 25. There was no significant difference between means of responses of different majors (*p* =.085) at significance level (*p* = 0.05).

Table 25
*ANOVA for question 14 (Level of Knowledge on the Use of Animal Manure as Fertilizer) Based on Majors*

| **Major** | ***n*** | ***M*** | ***SD*** | ***df*** | ***F*** | ***p*** |
|---|---|---|---|---|---|---|
| Agricultural Education – Graduate | 11 | 4.00 | .89 | 8 | 1.76 | .085 |
| General Agriculture with teacher certification | 18 | 3.94 | .87 | | | |
| Agribusiness Management – Ag. Systems | 16 | 3.56 | 1.53 | | | |
| Agribusiness Management – Horticulture | 38 | 3.55 | .98 | | | |
| Resource and Environmental Studies – Undergraduate | 65 | 3.54 | 1.05 | | | |
| Animal science – Pre vet | 20 | 3.40 | 1.05 | | | |
| General Agriculture | 40 | 3.33 | 1.14 | | | |
| Agribusiness Management | 36 | 3.25 | .94 | | | |
| Animal Science | 31 | 3.10 | 1.01 | | | |

**Significance level ($p$ < 0.05)**

Question 15 tested students' knowledge on the use of green manure (cover crops plowed under) in sustainable agriculture. Low means were obtained for this question implying that students had little knowledge about the practice. Agricultural Education graduate students obtained the highest mean (*M* = 3.45) followed by Agribusiness Management-Horticulture students (*M* = 3.26). Compared to other farm practices tested in the study most student groups obtained a lower mean which lies below the mid-point ($M$ = 3.00) for this practice. There was a significant difference ($p$ = .007) between means of the studied population groups at ($p$ < .05) as indicated on Table 26.

Table 26

*ANOVA for question 15 (Level of Knowledge on the Use of Green Manure/Cover Crop Plowed under) Based on Majors*

| **Major** | ***n*** | ***M*** | ***SD*** | ***df*** | ***F*** | ***p*** |
|---|---|---|---|---|---|---|
| Agricultural Education – Graduate | 11 | 3.45 | 1.44 | 8 | 2.72 | .007* |
| Agribusiness Management – Horticulture | 38 | 3.26 | 1.22 | | | |
| General Agriculture | 40 | 2.75 | 1.19 | | | |
| Resource and Environmental Studies – Undergraduate | 65 | 2.69 | 1.24 | | | |
| Agribusiness Management – Ag. Systems | 16 | 2.63 | 1.26 | | | |
| General Agriculture with Teacher Certification | 18 | 2.61 | 1.20 | | | |
| Agribusiness Management | 36 | 2.56 | 1.03 | | | |
| Animal science – Pre vet | 20 | 2.30 | 1.30 | | | |
| Animal Science | 31 | 2.16 | 1.16 | | | |

*** Significant at the *p* < 0.05 level**

A significant difference existed between the means of Animal Science and Agribusiness Management-Horticulture students. Values marked with an asterisk in Table 27 represent statistically significant difference in means at significance level ($p$ < .05). Table 27 shows the mean difference between majors on their level of knowledge on the use of green manure as a sustainable agricultural practice.

Table 27

*Mean Difference of Students Levels of Knowledge on Use of Green Manure/Cover Crop Plowed under (Tukey's HSD Test) Based on Majors*

| | **Ansc** | **AnscPv** | **GenAg** | **GenAgT** | **Agbm** | **AgbmH** | **AgbmAs** | **REnst** | **AgedG** |
|---|---|---|---|---|---|---|---|---|---|
| Ansc | - | -.14 | -.59 | -.45 | -.39 | -1.10* | -.46 | -.53 | -1.29 |
| AnscPv | .14 | - | -.45 | -.31 | -.26 | -.96 | -.33 | -.39 | -1.16 |
| GenAg | .59 | .45 | - | .14 | .19 | -.51 | .13 | .06 | -.71 |
| GenAgT | .45 | .31 | -.14 | - | .06 | -.65 | -.01 | -.08 | -.84 |
| Agbm | .39 | .26 | -.19 | -.06 | - | -.71 | -.07 | -.14 | -.90 |
| AgbmH | 1.10* | .96 | .51 | .65 | .71 | - | .64 | .57 | -.19 |
| AgbmAs | .46 | .33 | -.13 | .01 | .07 | -.64 | - | -.07 | -.83 |
| REnst | .53 | .39 | -.06 | .08 | .14 | -.58 | .07 | - | -.76 |
| AgedG | 1.29 | 1.16 | .71 | .84 | .90 | .19 | .83 | .76 | - |

*Statistically significant at the 0.05 level
[z]Mean differences are calculated as group in the row minus the group in the column

Cover crops are grasses, legumes or small grains grown between regular grain crop production periods for the purpose of protecting and improving the soil. Question 16 measured students' level of knowledge on cover crops as a sustainable agricultural practice. Agricultural Education graduate students had the highest mean ($M$ = 4.00) followed by Resource and Environmental Studies majors with a mean score of ($M$ = 3.54). Means obtained by other majors were recorded on Table 28 below. There was a significant difference ($p$ = .00) between means of different majors at ($p < 0.05$) level.

Table 28

*ANOVA for question 16 (Level of Knowledge on the Use of Cover Crops to Prevent Soil Erosion) Based on Majors*

| **Major** | ***n*** | ***M*** | ***SD*** | ***df*** | ***F*** | ***p*** |
|---|---|---|---|---|---|---|
| Agricultural Education – Graduate | 11 | 4.00 | 1.00 | 8 | 4.43 | .000* |
| Resource and Environmental Studies – Undergraduate | 65 | 3.54 | .95 | | | |
| Agribusiness Management – Horticulture | 38 | 3.50 | 1.13 | | | |
| Agribusiness Management | 36 | 3.14 | 1.02 | | | |
| General Agriculture with Teacher Certification | 18 | 3.06 | 1.06 | | | |
| Agribusiness Management – Ag. Systems | 16 | 2.88 | 1.26 | | | |
| General Agriculture | 40 | 2.80 | 1.34 | | | |
| Animal Science | 31 | 2.61 | 1.26 | | | |
| Animal science – Pre vet | 20 | 2.50 | 1.32 | | | |

*** Significant at the $p < 0.05$ level**

Significant differences existed between means of Animal Science majors and the following majors: Agribusiness Management-Horticulture, Resource and Environmental Studies, and Agricultural Education graduate students. Values marked with an asterisk in Table 30 illustrate the difference between the means of these groups. Animal Science majors obtained the lowest mean ($M$ = 2.61) creating a significant difference with the mean obtained by Agricultural Education graduate students ($M$ = 4.00), Resource and Environmental Studies ($M$ = 3.54), and Agribusiness Management-Horticulture ($M$ = 3.50). Table 29 indicates the mean difference explained above.

Table 29

*Mean Difference of Students Levels of Knowledge on Use of Cover Crops to Prevent Soil Erosion (Tukey's HSD Test) Based on Majors*

| | Ansc | AnscPv | GenAg | GenAgT | Agbm | AgbmH | AgbmAs | REnst | AgedG |
|---|---|---|---|---|---|---|---|---|---|
| Ansc | - | .11 | -.19 | -.44 | -.53 | -.89* | -.26 | -.93* | -1.39* |
| AnscPv | -.11 | - | -.30 | -.56 | -.64 | -1.00* | -.38 | -1.04* | -1.50* |
| GenAg | .19 | .30 | - | -.26 | -.34 | -.70 | -.08 | -.74* | -1.20 |
| GenAgT | .44 | .56 | .26 | - | -.08 | -.44 | .18 | -.48 | -.94 |
| Agbm | .53 | .64 | .34 | .08 | - | -.36 | .26 | -.40 | -.86 |
| AgbmH | .89 | 1.00* | .70 | .44 | .36 | - | .63 | -.04 | -.50 |
| AgbmAs | .26 | .38 | .08 | -.18 | -.26 | -.63 | - | -.66 | -1.13 |
| REnst | .93 | 1.04* | .74* | .48 | .40 | .04 | .66 | - | -.46 |
| AgedG | 1.39 | 1.50* | 1.20 | .94 | .86 | .50 | 1.13 | .46 | - |

*Statistically significant at the 0.05 level
[z]Mean differences are calculated as group in the row minus the group in the column

Reduced use of chemical fertilizers is another practice advocated for in practicing sustainable agriculture. Question 17 tested students' level of knowledge on this practice. Of all responses, Agricultural Education graduate students obtained the highest mean ($M$ = 3.82) followed by Agribusiness Management-Horticulture with a mean ($M$ = 3.52). Resource and Environmental studies ($M$ = 3.45), General Agriculture with Teacher Certification had ($M$ = 3.11). Mean obtained by other majors were recorded on Table 30 below. Though ANOVA indicated a significant difference ($p$ = .01) at ($p$ < .05) level, Post Hoc test (Tukey HSD) revealed no difference in means between specific groups. The reason was because of the unbalanced groups or different $n$ value. The smallest group was Agricultural Education graduate students (*n* = 11) and the largest group was Resource and Environmental Studies (*n* = 65).

Table 30

*ANOVA for question 17 (Level of Knowledge on Reduced Use of Chemical Fertilizers) Based on Majors*

| **Major** | ***n*** | ***M*** | ***SD*** | ***df*** | ***F*** | ***p*** |
|---|---|---|---|---|---|---|
| Animal Science | 31 | 2.74 | 1.03 | 8 | 2.52 | .012* |
| Animal science – Pre vet | 20 | 2.95 | 1.04 | | | |
| General Agriculture | 40 | 2.98 | 1.31 | | | |
| General Agriculture with Teacher Certification | 18 | 3.11 | 1.18 | | | |
| Agribusiness Management | 36 | 2.92 | .86 | | | |
| Agribusiness Management – Horticulture | 38 | 3.53 | 1.22 | | | |
| Agribusiness Management – Ag. Systems | 16 | 3.00 | .97 | | | |
| Resource and Environmental Studies – Undergraduate | 65 | 3.45 | 1.06 | | | |
| Agricultural Education – Graduate | 11 | 3.82 | .87 | | | |

*** Significant at the *p* < 0.05 level**

Question 18 tested students' level of knowledge on conservation tillage (no till farming). Students obtained low mean on this question when compared with other questions which measured students' level of knowledge. The highest mean was scored by Agricultural Education graduate students (*M* = 3.18) followed by Agribusiness Management-Horticulture (*M* = 2.95), General Agriculture with Teacher Certification (*M* = 2.94), Agribusiness Management (*M* = 2.81), Agribusiness Management-Ag systems

(*M* = 2.75). Mean obtained by other majors are recorded on Table 31. There was no significant difference in means between the different majors studied at ($p$ < .05) level.

Table 31

*ANOVA for question 18 (Level of Knowledge on Conservation Tillage/No Till Farming) Based on Majors*

| **Major** | ***n*** | ***M*** | ***SD*** | ***df*** | ***F*** | ***p*** |
|---|---|---|---|---|---|---|
| Animal Science | 31 | 2.06 | 1.06 | 8 | 1.99 | .05 |
| Animal science – Pre vet | 20 | 2.25 | 1.16 | | | |
| General Agriculture | 40 | 2.63 | 1.35 | | | |
| General Agriculture with Teacher Certification | 18 | 2.94 | 1.47 | | | |
| Agribusiness Management | 36 | 2.81 | .95 | | | |
| Agribusiness Management – Horticulture | 38 | 2.95 | 1.11 | | | |
| Agribusiness Management – Ag. Systems | 16 | 2.75 | 1.34 | | | |
| Resource and Environmental Studies – Undergraduate | 65 | 2.63 | 1.19 | | | |
| Agricultural Education – Graduate | 11 | 3.18 | 1.04 | | | |

**Significance level ($p$ < 0.05)**

The question on crop rotation obtained an average mean score from all the majors; there were no extreme mean values. The highest mean was by Agricultural Education graduate students (*M* = 4.00) followed by majors in Resource and Environmental Studies with a mean (*M* = 3.36). Lowest mean of (*M* = 3.00) was obtained by Animal Science-Pre Vet students. There was no significant difference between means of students studied at ($p$ < 0.05) level as indicated on Table 32.

Table 32

*ANOVA for the Level of Knowledge on Crop Rotation Based on Majors*

| **Major** | ***n*** | ***M*** | ***SD*** | ***df*** | ***F*** | ***p*** |
|---|---|---|---|---|---|---|
| Animal Science | 31 | 3.16 | 1.19 | 8 | 1.72 | .094 |
| Animal science – Pre vet | 20 | 3.00 | 1.26 | | | |
| General Agriculture | 40 | 3.05 | 1.34 | | | |
| General Agriculture with Teacher Certification | 18 | 3.44 | 1.45 | | | |
| Agribusiness Management | 36 | 3.31 | 1.01 | | | |
| Agribusiness Management – Horticulture | 38 | 3.34 | 1.07 | | | |
| Agribusiness Management – Ag. Systems | 16 | 3.38 | 1.20 | | | |
| Resource and Environmental Studies – Undergraduate | 65 | 3.65 | 1.01 | | | |
| Agricultural Education – Graduate | 11 | 4.00 | 1.83 | | | |

**Significance level ($p$ < 0.05)**

Students' level of knowledge on genetically modified crops was determined and results recorded in Table 34. Of all participants, Agricultural Education graduate students obtained the highest mean of (*M* = 3.55), students majoring in General Agriculture with Teacher Certification (*M* = 3.44), Resource and Environmental Studies students scored a mean of (*M* = 3.40). There was no significant difference between means of different participants based on their major field of studies. Table 33 indicates overall means for all the majors studied for this question.

Table 33

*ANOVA for question 20 (Level of Knowledge on Genetically Modified Crops) Based on Majors*

| **Major** | ***n*** | ***M*** | ***SD*** | ***df*** | ***F*** | ***p*** |
|---|---|---|---|---|---|---|
| Animal Science | 31 | 2.87 | 1.09 | 8 | 1.16 | .322 |
| Animal science – Pre vet | 20 | 3.15 | 1.35 | | | |
| General Agriculture | 40 | 3.08 | 1.27 | | | |
| General Agriculture with Teacher Certification | 18 | 3.44 | 1.15 | | | |
| Agribusiness Management | 36 | 2.89 | .95 | | | |
| Agribusiness Management – Horticulture | 38 | 3.21 | 1.36 | | | |
| Agribusiness Management – Ag. Systems | 16 | 3.00 | 1.32 | | | |
| Resource and Environmental Studies – Undergraduate | 65 | 3.40 | 1.09 | | | |
| Agricultural Education – Graduate | 11 | 3.55 | 1.04 | | | |

**Significance level ($p < 0.05$)**

Integrating crop and livestock farming enterprises is an economical way of maximizing agricultural production from a single farming unit. Question 21 sought to determine students' level of knowledge on this practice based on their majors. Means obtained by most groups/majors for this question were below the mid-point ($M = 3.00$). The highest mean was obtained by Agricultural Education graduate students ($M = 3.36$), followed by majors in General Agriculture with Teacher Certification ($M = 2.89$). Mean results obtained by other majors are recorded in Table 34. There was no significant mean difference between the majors studied at ($p < .05$) level.

Table 34

*ANOVA for question 21 (Level of Knowledge on Mixed Farming/Combined Crop and Livestock Enterprises) Based on Majors*

| **Major** | ***n*** | ***M*** | ***SD*** | ***df*** | ***F*** | ***p*** |
|---|---|---|---|---|---|---|
| Animal Science | 31 | 2.45 | 1.18 | 8 | .98 | .45 |
| Animal science – Pre vet | 20 | 2.35 | 1.04 | | | |
| General Agriculture | 40 | 2.56 | 1.31 | | | |
| General Agriculture with Teacher Certification | 18 | 2.89 | 1.23 | | | |
| Agribusiness Management | 36 | 2.72 | 1.62 | | | |
| Agribusiness Management – Horticulture | 38 | 2.55 | 1.32 | | | |
| Agribusiness Management – Ag. Systems | 16 | 2.44 | 1.32 | | | |
| Resource and Environmental Studies – Undergraduate | 65 | 2.68 | 1.33 | | | |
| Agricultural Education – Graduate | 11 | 3.36 | 1.36 | | | |

*** Significance level ($p$ < 0.05)**

Question 21 measured students' level of knowledge on agricultural recycling. Students were asked to rate their level of knowledge on recycling of agricultural wastes (e.g. crop residues). Agricultural Education graduate students obtained the highest mean ($M$ = 3.64) as compared to the scores obtained by the other majors; Resource and Environmental Studies students ($M$ = 3.22); General Agriculture with Teacher Certification ($M$ = 3.17). Means obtained by the other majors studied were recorded in Table 35 below. Though ANOVA indicated significant difference between means ($p$ = .022), Tukey test showed no specific groups with significant difference. Difference in sample sizes explains why Tukey test could not generate pairs with significant difference.

Table 35

*ANOVA for question 22 (Level of Knowledge on Recycling Agricultural Wastes/Crop and Animal Residues) Based on Majors*

| **Major** | ***n*** | ***M*** | ***SD*** | ***df*** | ***F*** | ***p*** |
|---|---|---|---|---|---|---|
| Animal Science | 31 | 2.42 | 1.15 | 8 | 2.29 | .022* |
| Animal science – Pre vet | 20 | 2.45 | 1.28 | | | |
| General Agriculture | 40 | 2.87 | 1.32 | | | |
| General Agriculture with Teacher Certification | 18 | 3.17 | 1.20 | | | |
| Agribusiness Management | 36 | 2.81 | 1.12 | | | |
| Agribusiness Management – Horticulture | 38 | 3.03 | 1.31 | | | |
| Agribusiness Management – Ag. Systems | 16 | 2.69 | 1.08 | | | |
| Resource and Environmental Studies – Undergraduate | 65 | 3.22 | 1.15 | | | |
| Agricultural Education – Graduate | 11 | 3.64 | 1.12 | | | |

*** Significant at the *p* < 0.05 level**

**Findings to Objective #4 – assessing the level of importance students place on implementation of selected sustainable agricultural practices in college curriculum**

Overall means for the levels of importance that students place on the implementation of sustainable agriculture topics in undergraduate curriculum are shown on Table 36. Most students perceived reduced use of chemical fertilizer as a very important sustainable agriculture practice ($M$ = 4.40); thus it should be included in college curricula. Conservation tillage scored the lowest mean, ($M$ = 3.89) when compared to the mean of other practices as it appears on Table 36 below.

Table 36

*Overall Means of Perceived Levels of Importance that Students Place on Implementation of Selected Sustainable Agricultural Practices in College Curricula*

| **Practice** | ***n*** | ***M**** | ***SD*** |
|---|---|---|---|
| Reduced use of chemical fertilizers | 273 | 4.40 | .80 |
| Recycling agricultural wastes | 273 | 4.38 | .78 |
| Crop rotation | 273 | 4.35 | .81 |
| Reduced use of herbicides & pesticides | 272 | 4.33 | .86 |
| Use of cover crops to prevent soil erosion | 273 | 4.27 | .82 |
| Rotational grazing | 273 | 4.15 | .90 |
| Use of animal manure as fertilizer | 273 | 4.08 | .91 |
| Use of green manure (cover crop plowed under) | 272 | 4.00 | .96 |
| Genetically modified crops | 273 | 3.99 | 1.06 |
| Integrated pest management | 273 | 3.94 | 1.00 |
| Conservation tillage (e.g. no till farming) | 273 | 3.89 | .96 |

*Scale: 1=Not Important, 2=Little Importance, 3=Somehow Important, 4= Moderately Important, 5=Very Important

# CHAPTER V

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to determine the perceptions of agriculture and resource and environmental studies students at Texas State towards sustainable agriculture. To accomplish this, questions were developed to address the objectives of the study which were: (1) to determine students' extend of agreement with statements related to sustainable agriculture, (2) to determine students' level of knowledge on selected sustainable agricultural practices, (3) to determine the difference in students' level of knowledge on selected sustainable agriculture practices based on their majors, and (4) to determine the level of importance that students place on the implementation of selected practices in undergraduate curriculum.

**Summary of the literature review**

As it pertains to agriculture, sustainable describes farming systems that are capable of maintaining their productivity and usefulness to society indefinitely. Such systems must be resource-conserving, socially supportive, commercially competitive, and environmentally sound (Duesterhaus, 1990). Economically sound, environmentally protective, and socially acceptable are the three widely advocated components of sustainable agriculture that any agricultural educator should consider in developing his or her curriculum.

The National Council for Agricultural Education in its 1988 mission statement, "Reinventing Agricultural Education for the Year 2020", stressed the need to prepare high school and college students for successful careers and a lifetime of informed choices in the global agricultural industry, and natural resource management. Proper student preparation is important in enhancing the theme of sustainability. Curriculum materials should equip students with appropriate knowledge on how to utilize available resources to generate a lifetime stream of satisfaction. The goal is an education system that prepares high school and college students in agriscience, and promotes the study and application of sustainable agriculture for solutions to the problems of resource depletion and environmental misuse (Williams, 2000).

Shortcomings of the traditional curriculum may range from too much emphasis on the farm as the only business model and the teaching of agriculture solely as a vocational subject (Borsari, 2001). Agricultural education needs to address elements of emerging agriculture including sustainable production, processing, marketing, and distribution systems. Students should learn about farming systems that are economically profitable, environmentally sound, and socially acceptable. Williams (2000) acknowledged the role played by past studies in campaigning for the inclusion of sustainable agriculture into the agricultural curriculum. He argues that such a move can facilitate solutions to the current problems in agriculture, stimulate rural economic development, enrich scientific teaching of agriculture, and strengthen work skills for college students.

Borsari (2001) studied undergraduate agriculture curricula related to sustainability and found out some concepts which were difficult for U.S. students to understand. Biological pest control, rotational grazing, agro-ecosystem, and sustainable agriculture were among those concepts. For sustainable agriculture, the students had difficulty deciding what farming practices can become more sustainable, in what kind of environment, and in what social contexts. Borsari (2001) noted the difficulty and proposed that the complexity of this issue deserves much attention from every stratum of human society. There is, therefore, a need to improve curricula in the agricultural sciences to incorporate elements of sustainable agriculture that young agriculturists are not familiar with and enable them to make sound decisions with scarce or limited resources. Sustainability deals with how to handle the scarce resources to provide a stream of satisfaction way long into the future.

The incorporation of principles or courses in sustainable agriculture, environmental science, policy, and holistic management, are provided when students enroll in graduate programs (Borsari and Vidrine, 2005). It therefore appears that it is at the graduate level that students become well grounded in education and are able to comprehend issues concerned with modern agriculture and its challenges from a more sustainable perspective. This limitation is unfortunate, as undergraduate students could achieve similar comprehension if provided with appropriate educational opportunities regarding the topic.

## Methods and Procedures

### Design of the survey

Qualtrics survey software was used in data collection. The survey was split into two sections; section one comprised a set of demographic questions on gender, college major, ethnicity, education classification, area they grew up, and age. The question that sought to establish the source that students gained most exposure to sustainable agriculture marked the end of section one. Several source options were provided for students to choose from. The options were classified based on different levels of education: high school, undergraduate and graduate levels. Graduate and undergraduate levels were further classified into different college majors relative to student population studied. Independent variables in the study were gender, major, age, the area where the student grew up and ethnicity.

Section two of the survey comprised Likert-type scale questions addressing objectives 1 through 4. The first question in this section asked students to rate their level of agreement with statements related to sustainable agriculture on the following Likert-type scales: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree (The statements are contained in the survey document at the appendix of this thesis). The second question asked the students to rate their level of knowledge on twelve sustainable agricultural practices on the following Likert-type scales: 1 = No Knowledge, 2 = Little Knowledge, 3 = Some Knowledge, 4 = Moderate Knowledge, 5 = High knowledge. (The sustainable agricultural practices rated above appear in the survey in the appendix of this thesis). The third and last question asked students to rate the level of importance they place on the implementation of sustainable agricultural practices (rated in question 2 above) in undergraduate curriculum. The items were scored on a five-point Likert-type scale where “1” indicated *unimportant*, “2” indicated *of little importance*, “3” indicated *somehow important*, “4” indicated *moderately important*, and “5” indicated *very important*.

The survey instrument was developed based on literature review and suggestions from faculty members in the Department of Agriculture at Texas State. To account for reliability, a pilot test was conducted with a group of 16 students from the Department of

Agriculture. The pilot test reported Cronbach alpha coefficients of .93, .94, and .84 for the knowledge, importance and general statements, respectively.

**Population**

Both graduate and undergraduate students enrolled in Agriculture and Geography Departments of Texas State were surveyed. Purposive sampling was used to select students from the department of Geography with only majors in resource and environmental studies participating in the study. All graduate and undergraduate majors in the Department of Agriculture were surveyed. A pilot test was conducted with a group of 16 students from the department of agriculture who were not part of the 500 sampled for the study. The population studied comprised 219 students from Geography Department and 281 from the Agriculture Department; a total of 500 students.

**Collection of data**

Qualtrics survey software was used in data collection. Qualtrics provides a platform for designing and distributing surveys. Initial survey emails were sent on January 26, 2011 to a total of 500 students from the departments of Agriculture and Geography; 281 and 219 respectively. The email contained: an introduction from the researcher, an explanation of the survey, an invitation to participate, a drawing offer of $25 Walmart gift card for two lucky survey participants, and a link to the survey. A statement regarding the approval of the study by Texas State Institutional Review Board was also made on the cover page. Students were given a period of two weeks to complete and submit the survey.

By the end of two weeks, a total of 104 students had responded. The calculated response rate following the first email was 17.8%. On February 9, 2011, a reminder email was sent to students who had not responded, and to those who had started but did not finish the survey. One week was given for the two groups to complete the survey.

On February 17, 2011, student responses had totaled 147; an addition of 43 to the first round of email. A second reminder email was sent and the students asked to respond by February 24, 2011. One hundred and sixty five students had responded by February 24, 2011. Third and final reminder emails were sent on the $24^{th}$ February, 2011. Two weeks following the final reminder 180 students had responded.

To improve the response rate, hard copies of the instrument were made and distributed to students who had not responded to the online survey. This exercise was made successful by cooperative faculty in the Department of Agriculture who asked students to volunteer and complete the survey using the first five minutes of their class time; just before lessons begun. One hundred and twenty two surveys were received by the end of one week. Data collected via Qualtrics were uploaded directly into an SPSS 13.0 data file. One hundred and twenty two paper surveys were entered manually to SPSS. A total of 302 of the 500 students responded, yielding an overall response rate of 60.4%.

**Data Analysis**

The results of the survey were reported using descriptive statistics: overall response rate, means, standard deviations and frequencies for each question. *T-tests* were used to evaluate the differences in overall means of male and female students. Analysis of variance (ANOVA) was used to determine if the difference between means of students (based on their college major) was statistically significant.

**Conclusions**

Economically sound, environmentally protective, and socially acceptable are the three widely advocated components of sustainable agriculture that any agricultural educator should consider in developing curriculum. Researchers have advanced that sustainability education that infuses curriculum and instruction with concepts linking social, economic and ecological systems will enable students to understand the interactions among the three systems and the current sustainable agricultural practices (Santone, 2004). The purpose of this study was to determine the perceptions of Texas State students towards sustainable agriculture based on the three components mentioned above: Economically sound, environmentally protective, and socially acceptable. Following is the discussion of the results obtained for the three objectives.

**Objective one**

The first objective was to determine students' level of agreement with statements related to sustainable agriculture. These statements described the three widely advocated components of sustainable agricultural practices (economically sound, environmentally protective, and socially acceptable) mentioned in the previous section. The statement that sustainable agriculture production promotes the well-being of our ecosystem generated the highest overall mean ($M$ = 4.28) as shown in Table 6. According to McIsaac (1996), "sustainable agriculture is a system of agriculture in which food and fiber is produced using agricultural technologies and methods that conserve natural and non-renewable resources while ensuring a social, economic, and ecological continuity of the system in the long-term". The overall mean ($M$ = 4.28) implied that students were in agreement with the statement. Following closely is the statement that sustainable agriculture conserves the natural resources with an overall mean (*M* = 4.27). These two statements were closely related in meaning with the later being slightly specific on the elements of the ecosystem. The statement that sustainable agriculture assures profitable returns to farmers generated the lowest mean (*M* = 3.47). It was an open statement not specific to a particular farming practice or enterprise.

In order to make comparisons of students' perceptions based on independent variables; students were first classified according to various demographic groups: gender, age, college major, ethnicity, and areas where they grew up. For the purpose of this study the researcher focused mainly on students' field of academic specialization (college major) as a basis of comparisons. Table 4 summarized participants' population based on majors: 24% Resource and Environmental Studies, 14.2% General Agriculture, 13.2% Agribusiness management, 12.6% Agribusiness Management-Horticulture, 11.6% Animal Science, 7.0% Animal Science-Pre Vet, 6.6% General Agriculture with Teacher Certification, Agribusiness-Ag Systems 5.6, and Agricultural Education graduate students 4.0%.

When comparisons of students' perceptions on the statement that sustainable agriculture production promotes the well-being of the ecosystem was made, Resource and Environmental Studies students obtained the highest mean (*M* = 4.55) followed closely by Agribusiness Management – Horticulture (*M* = 4.53) as shown in Table 11. The Texas State undergraduate course catalog indicates that more courses dealing with environmental management and natural resource conservation are offered during the first two years of undergraduate degree programs in the Department of Geography. The question that asked students to select the source of most exposure to sustainable agriculture confirms this. Of the 75 Resource and Environmental Studies respondents, 67 chose undergraduate geography courses taken at Texas State as their major source of exposure to the topic as shown in Table 5.

Agribusiness Management – Horticulture students obtained a mean ($M$ = 4.53); second highest. One hundred and fifty two students from the Department of Agriculture representing 50.3% of respondents chose undergraduate agriculture courses taken at Texas State as their major source of exposure to sustainable agriculture. This implies that students in the department of agriculture gain most exposure to the topic in the course of their undergraduate degrees too. The difference in means obtained between students from the Department of Agriculture and that of Geography could be explained by either the timing when the course is offered by each Department or by the composition of respondents from the two departments. Resource and Environmental Studies students took Introduction to Environmental Geography and other related courses during their first two years of undergraduate degree. In addition, it (Resource and Environmental Studies) was the only major selected for study from the Department of Geography. On the other hand respondents from the Department of Agriculture comprise students in different majors: Animal science, Agribusiness Management – Ag. Systems and/or Horticulture, General Agriculture with Teacher Certification (The full list of college majors studied appear in the appendix of this thesis). This explains the variation in mean obtained by different majors in the Department of Agriculture.

Resource and Environmental Studies students obtained the highest mean for the statement that sustainable agriculture conserves natural resources ($M$ = 4.55) followed by Agricultural Education graduate students ($M$ = 4.45). Of the nine college majors studied only two majors obtained a mean less than (*M* = 4.03): General Agriculture (*M* 3.98) and Animal Science – Pre Vet (*M* = 3.95) as shown in Table 7. These results imply that students were generally in agreement with the statement that sustainable agriculture conserves natural resources. The statement that sustainable agriculture production promotes long term land productivity produced similar results with Resource and Environmental Studies students obtaining the highest mean (*M* = 4.60) followed by Agribusiness Management – Horticulture (*M* = 4.42). Animal Science (M = 3.94) and General Agriculture (*M* = 3.93) students were the only students with mean below 4.00.

The overall means for students' perceptions on the inclusion of sustainable agriculture courses in college curricula ranked Agricultural Education graduate students at the top (*M* = 4.45), followed by majors in General Agriculture with Teacher Certification (*M* = 4.28). Animal Science-Pre Vet (*M* = 3.60) and General Agriculture (*M* = 3.63) majors obtained the lowest mean as shown in Table 15. Borsari and Vidrine (2005) believed that incorporation of courses in sustainable agriculture is made when students enroll in graduate programs. This implies that, it is at the graduate level that students become well grounded in education and are able to understand issues concerned with modern agriculture and its challenges from a more sustainable perspective. Parr, Trexler, Khanna, and Battisti (2007) agreed with the idea that students positively perceive the integration sustainability topics in the agriculture curriculum across the nation.

**Objective two**

Objective two sought to determine students' level of knowledge on selected sustainable agricultural practices. Borsari (2001) studied undergraduate agricultural curricula related to sustainability and found some concepts were difficult for U.S.

students to understand. Biological pest control, rotational grazing, agro-ecosystem, and sustainable agriculture were among those concepts. In this study the researcher measured students' level of knowledge on 12 sustainable agricultural practices: Integrated pest management (combined pest-control practices), recycling agricultural wastes, rotational grazing, reduced use of herbicides and pesticides, use of animal manure as fertilizer, use of green manure (cover crop plowed under), use of cover crops to prevent soil erosion, reduced use of chemical fertilizers, conservation tillage (e.g. no till farming), crop rotation, genetically modified crops, and integrating plant crops with livestock enterprises (mixed farming).

Overall means for students' level of knowledge on the practices listed above were determined and results recorded in Table 17. Use of animal manure as a fertilizer had the highest mean ($M$ = 3.46) with a standard deviation of ($SD$ = 1.04) across the entire population studied. Students' level of knowledge on crop rotation obtained ($M$ = 3.36); second highest mean. It was very disappointing that the widely advocated practice of integrated pest management generated the lowest mean ($M$ = 2.57). Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of available pest control methods to manage pest damage. IPM uses the most economical means which are least hazardous to people, property, and the environment to control pests. Integrating plant crops with livestock enterprises (Mixed farming) had the second lowest mean ($M$ = 2.63). It refers to the use of a single farm for multiple purposes such as the growing of cash crops and raising of livestock.

**Objective three**

Objective three was to determine the difference in students' level of knowledge on selected sustainable agriculture practices based on college majors. Analysis of variance (ANOVA) was used to determine if there was a significant difference between means of different college majors. ANOVA for the level of knowledge on integrated pest management revealed a significant difference in means ($p$ = .00) at ($p$ < .05). Agricultural Education graduate students obtained the highest mean ($M$ = 3.73) and a standard deviation ($SD$ = 1.10). Agribusiness Management-Horticulture was second with a mean ($M$ = 3.32), ($SD$ = .81). The lowest mean for the practice was by Animal Science majors who reported a mean of ($M$ = 1.77). The lowest mean ($M$ = 1.77) represented *No Knowledge* and the highest ($M$ = 3.73) represented *Moderate Knowledge* on Likert-type scale. Generally, undergraduate students from the two Departments reported low means for this practice. Low means obtained by Animal Science students indicated that little is covered on crop science in their curriculum. Muma (2006) proposed an interdisciplinary move to address issues regarding sustainability. He argued that interdisciplinary perspectives are very crucial in reinforcing new forms of learning in solving complex problems on sustainability.

Analysis of variance (ANOVA) for level of knowledge on rotational grazing revealed a significant difference in means ($p$ = .005) at ($p$ < .05). Agricultural Education graduate students had the highest mean ($M$ = 3.91) followed closely by General Agriculture with Teacher Certification ($M$ = 3.69). The lowest mean ($M$ = 2.65) was by Animal Science-Pre Vet students. Findings to objective three confirmed what other related past studies found; Borsari and Vidrine (2005) argued that more courses in sustainable agriculture are provided when students enroll in graduate programs. This limitation is unfortunate, as undergraduate students could achieve similar comprehension if provided with appropriate educational opportunities regarding the topic. According to Francis et al. (2001) sustainable agriculture is an interdisciplinary field of study which demands integrated effort from experts in different disciplines to address many "complex societal and environmental problems in the agri-food system that have heretofore been unapproachable by single disciplines".

**Objective four**

Objective four was to determine the level of importance that students place on the implementation of selected practices in undergraduate curriculum. Overall means of perceived levels of importance that students place on implementation of sustainable agricultural practices in college curriculum were obtained and recorded in Table 36. To make credible conclusions, overall means for students' level of knowledge was compared with their perceived level of importance on implementation of selected sustainable agricultural practices in college curriculum. It was quite interesting to find out that those practices that students reported low levels of knowledge similarly reported low levels of importance in their inclusion in undergraduate curriculum.

Students obtained the lowest mean for their level of knowledge on integrated pest management ($M$ = 2.57) and second lowest mean ($M$ = 3.94) for the level of importance they place on the implementation of the topic (IPM) in undergraduate curriculum. Reduced use of chemical fertilizers received the highest rating on importance ($M$ = 4.40) followed closely by recycling agricultural wastes ($M$ = 4.38); crop rotation was third ($M$ = 4.35). Conservation tillage ($M$ = 3.89), IPM ($M$ = 3.94), and genetically modified crops

(*M* = 3.99) received the lowest rating on their level of importance. Cardwell (1995) argued that including sustainable agriculture in school curriculum provides an opportunity for agricultural education to connect the applied sciences to the food and fiber system; thus an opportunity to enrich instruction with science and technology. Integration of social sciences, production economics, and environmental sciences in a move towards sustainability improves agricultural curriculum. Marshall and Herring (1991) believed that topics in sustainable agriculture should be integrated into the curriculum.

**Implications**

Educational systems that integrate curriculum and instruction with concepts linking social, economic and ecological systems are appropriate for the present age agricultural students. Such educational systems will enable students to understand patterns of interactions among the above three systems and current sustainable agricultural practices. Findings from this study indicated that students positively perceived the concept of sustainable agriculture and its principles in promoting the well being of the ecosystem. Despite their low levels of knowledge on most sustainable practices, the participants depicted a desire to learn more about the topic. Their agreement with the statement that sustainable agriculture courses should be included in college curriculum confirmed students' interest in the topic. There is therefore a need to improve curricula in the agricultural sciences to incorporate elements of sustainable agriculture that young agriculturists are not familiar with thus enabling them to make sound decisions with scarce resources. Sustainability defines ways and means of handling scarce resources to provide a stream of satisfaction way long into the future.

Traditional curriculum needs to be amended to reflect the theme of sustainability. Students' knowledge on sustainable farm practices should be tested to ensure that they can adequately draw a line between sustainable and conventional farming practices. They should also be equipped with relevant knowledge on how to transform conventional farming practices to sustainable practices. Integrated pest management (IPM) is a widely advocated practice in abating pest infestation. It is a practice that is applicable not only within agricultural setting, but also in schools, homesteads and in other different settings susceptible to pest infestation. Students should be able to understand how to implement the practice at different settings. IPM uses the most economical means which are least hazardous to people, property, and the environment to control pests. Depending on the environment and the way they are implemented all the practices mentioned in this study qualify to be sustainable. It is therefore the responsibility of agricultural educators to pass relevant knowledge to young agriculturalists on how to make such practices sustainable.

**Recommendations**

Based on findings related to the three research questions it is possible to make the following recommendations:

1. Undergraduate agricultural curriculum needs to be improved to include more topics in sustainable agriculture.
2. Positive perception towards sustainable agriculture should be reinforced to change learners' attitudes towards this very important topic.

3. Possible reasons why sustainable agriculture is not taught satisfactorily in high schools, colleges, and universities should be established and addressed appropriately.
4. Difference in students' level of knowledge on the topic across disciplines and/or majors calls for further scientific inquiry into possibilities of advocating interdisciplinary measures to promote the topic.
5. An education system that integrates curriculum and instruction with concepts linking social, economic and ecological systems.

**APPENDIX A**

EMAILED REQUEST FOR PARTICIPATION

Sustainable Agriculture
noreply@qemailserver.com [noreply@qemailserver.com]
Sent: Wednesday, January 26, 2011 11:19 AM
To:

Hello Texas State University students

Dr. Doug Morrish and I are conducting a study on sustainable agriculture, a popular topic in most current agricultural studies. This wave of popularity ignites a need to transfer the research findings to practice by restructuring college and high school agricultural curriculum to include courses in sustainability. Findings from this study will promote professional development efforts in the field of sustainable agriculture.

You participation in this survey enters you into a drawing to win a $25.00 Walmart gift card. If you have any concerns regarding this survey, please feel free to contact me by email at *is1035@txstate.edu* or my supervisor at *dm43@txstate.edu*. This project has been approved by the Texas State University Institutional Review Board (IRB Exemption # EXP201013849).

**Please respond to this survey by February 9, 2011.**

**Follow this link to the Survey:**
Take the Survey

Or copy and paste the URL below into your internet browser:
http://qacademics.qualtrics.com/WRQualtricsSurveyEngine/?Q_SS=3sM0fa3lmbcNnzC_8erN0PqArlnJauM&_=1

Follow the link to opt out of future emails:
http://qacademics.qualtrics.com/CP/Register.php?OptOut=true&RID=MLRP_eJRqFN9rikzS4UQ&LID=UR_ePDeLyQIrTXQB9i&_=1

Dr. Doug Morrish - Assistant Professor
Isaac Sitienei - Graduate Student
Texas State University- Department of Agriculture

**APPENDIX B**

THE SURVEY

**Demographics**

Please check the option that best describe you

1) Gender
   Male
   Female

2) Major
   Animal Science
   Animal Science – Pre Vet
   General Agriculture
   General Agriculture with teacher certification
   Agribusiness Management
   Agribusiness Management – Horticulture
   Agribusiness Management – Ag. Systems
   Resource and Environmental Studies – Undergraduate
   Resource and Environmental Studies – Graduate
   Agricultural Education – Graduate

3) Education classification: Freshman, sophomore, Junior, Senior, Graduate

4) Ethnicity
   Caucasian/white
   African American
   Asian
   Hispanic
   Other____

5) Which area best describes where you grew up:
   Farm/ranch
   County but not a farm/ranch
   Town of less than 5000
   City of 5000-50000
   City of 50000-1M
   Metropolitan of more than 1M

6) Age in years
   20 and below
   21 – 25

26 – 30
31-35
36 and above

7) Please indicate the source of **MOST** exposure to sustainable agriculture

a) High school courses
b) Undergraduate Geography courses taken at this university
c) Undergraduate Geography courses taken at a different university
d) Undergraduate Agriculture courses taken at this university
e) Graduate Geography courses taken at this university
f) Graduate Agriculture courses taken at this university
g) Professional development
h) Other_____

8) Please indicate the extent you agree or disagree with each of the following statements regarding sustainable agriculture by checking the appropriate number on the 5-point scale Strongly Disagree (SD) = 1, Disagree (D) = 2, Neutral (N) = 3, Agree (A) = 4, Strongly Agree (SA) = 5

| | SD | D | N | A | SA |
|---|---|---|---|---|---|
| Sustainable agriculture production conserves natural resources | 1 | 2 | 3 | 4 | 5 |
| Sustainable agriculture production allows farmers to sell products locally | 1 | 2 | 3 | 4 | 5 |
| Sustainable agriculture production assures profitable returns from farm enterprises | 1 | 2 | 3 | 4 | 5 |
| Sustainable agriculture production promotes long-term land productivity | 1 | 2 | 3 | 4 | 5 |
| Sustainable agriculture production promotes the well-being of our ecosystem | 1 | 2 | 3 | 4 | 5 |
| Courses in sustainable agriculture production should be included in all college curricula | 1 | 2 | 3 | 4 | 5 |
| Sustainable agriculture production reduces ground water contamination | 1 | 2 | 3 | 4 | 5 |
| Sustainable agriculture production promotes food safety | 1 | 2 | 3 | 4 | 5 |
| Sustainable agriculture production benefits small-scale landowners/farmers | 1 | 2 | 3 | 4 | 5 |
| Sustainable agriculture production increases farm income | 1 | 2 | 3 | 4 | 5 |

9) Please indicate your level of knowledge on the following sustainable agriculture practices by choosing the appropriate number on the five point scale
1=No Knowledge (NK), 2 = Little Knowledge (LK), 3 = Some Knowledge (SK), 4 = Moderate Knowledge (MK), 5 = High knowledge (HK)

| | NK | LK | SK | MK | HK |
|---|---|---|---|---|---|
| Integrated pest management (combined pest-control practices) | 1 | 2 | 3 | 4 | 5 |
| Rotational grazing | 1 | 2 | 3 | 4 | 5 |
| Reduced use of herbicides & pesticides | 1 | 2 | 3 | 4 | 5 |
| Use of animal manure as fertilizer | 1 | 2 | 3 | 4 | 5 |
| Use of green manure (cover crop plowed under) | 1 | 2 | 3 | 4 | 5 |
| Use of cover crops to prevent soil erosion | 1 | 2 | 3 | 4 | 5 |
| Reduced use of chemical fertilizers | 1 | 2 | 3 | 4 | 5 |
| Conservation tillage (e.g. no till farming) | 1 | 2 | 3 | 4 | 5 |
| Crop rotation | 1 | 2 | 3 | 4 | 5 |
| Genetically modified crops | 1 | 2 | 3 | 4 | 5 |
| Integrating plant crops with livestock enterprises | 1 | 2 | 3 | 4 | 5 |
| Recycling agricultural wastes | 1 | 2 | 3 | 4 | 5 |

10) Please rate the level of importance you place on the implementation of the following SA practices into the undergraduate and graduate curriculum
1 = Not Important (NI), 2 = Little Importance (LI), 3 = Somehow Important (SI), 4 = Moderately Important (MI), 5 = Very Important (VI)

| | NI | LI | SI | MI | VI |
|---|---|---|---|---|---|
| Integrated pest management (combined pest-control practices) | 1 | 2 | 3 | 4 | 5 |
| Rotational grazing | 1 | 2 | 3 | 4 | 5 |
| Reduced use of herbicides & pesticides | 1 | 2 | 3 | 4 | 5 |
| Use of animal manure as fertilizer | 1 | 2 | 3 | 4 | 5 |
| Use of green manure (cover crop plowed under) | 1 | 2 | 3 | 4 | 5 |
| Use of cover crops to prevent soil erosion | 1 | 2 | 3 | 4 | 5 |
| Reduced use of chemical fertilizers | 1 | 2 | 3 | 4 | 5 |
| Conservation tillage (e.g. no till farming) | 1 | 2 | 3 | 4 | 5 |
| Crop rotation | 1 | 2 | 3 | 4 | 5 |
| Genetically modified crops | 1 | 2 | 3 | 4 | 5 |
| Recycling agricultural wastes | 1 | 2 | 3 | 4 | 5 |

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## VITA

Isaac Sitienei was born in Kapsabet, Kenya, on September 3, 1979, the son of Leah Jeptarus Sitienei and the Late Joel K. Chelulei. After graduating from Terige High School, Kenya in 1998, he joined Egerton University. He received the degree of Bachelor of Science in Agricultural Economics from Egerton in September 2005. During the following years he was employed as a research assistant with Tegemeo Agricultural Research Center in Kenya. In August 2009, he entered the Graduate College of Texas State University-San Marcos.

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