College Students' Knowledge of Sustainable Agriculture and its Implications on the Agricultural Education Curriculum[1]

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Abstract

The purpose of the study was to assess college students' level of agreement with statements defining sustainable agricultural practices and their knowledge level of twelve selected sustainable practices. A total of 500 students from the Departments of Agriculture and Geography were selected to participate in the study, out of which, 301 responded, for a 60.2 % response rate. The results of the study indicate that students were in general agreement with statements defining sustainable agriculture. However, many students indicated having little knowledge on the most common sustainable agricultural practices. Out of the twelve sustainable agricultural practices analyzed, students indicated that they had the least knowledge on integrated pest management (IPM) (M = 2.57) and the most knowledge on using animal manure as fertilizer (M = 3.46). Mean comparison of students' knowledge levels on each of the practices generated the highest mean for the Agricultural Education graduate students. Animal Science majors indicated having the least knowledge in eight out of the 12 practices. Results from this study indicate a clear need for additional efforts from agricultural educators to incorporate sustainable agriculture topics into their curricula.

Introduction

Sustainability rests on the principle that we use available natural resources to meet our present needs without compromising the ability of future generations to derive enough satisfaction from the same set of resources (Muma et al., 2010). In general terms, an activity is considered sustainable if it can be carried out indefinitely without depleting resources. Futures forecasting and early adoption constituents indicate that agricultural systems must provide the food and fiber that humanity needs today, but also be able to sustain what the human family will require a decade or even a century from now (Robertson and Swinton, 2005). Educational systems will need to equip students with the knowledge of sustainable agriculture as a viable solution to combat the problems of resource depletion and environmental misuse.

Inclusion of sustainable agriculture topics in both the high school and college agriculture curriculum can provide solutions to the environmental problems associated with production. Williams (2000) indicated that a sustainable agriculture curriculum could indeed enhance a lasting rural economic development by enriching the scientific teaching of agriculture in colleges and schools. This in turn strengthens and expands college students' prowess. One of the most common inadequacies of the traditional agriculture curriculum may range from too much emphasis on classwork but very little hands-on activities in the field (Borsari, 2001). Experiential learning approach to agriculture avails a practical education system to students. Linking the real world with the classroom should be the concern of every curriculum developer. Sustainable agriculture is an interdisciplinary field in nature that offers solutions to complex societal and environmental problems in the agri-food system, all of which have been unapproachable by any single discipline in agriculture (Francis et al., 2003).

Keating et al. (2010) indicated that a highly technical curriculum for high school and college students

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is mandatory to adequately prepare students for successful careers and enable them to make informed choices in the global agricultural and natural resource management industries. Proper curriculum development and 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. This paper contributes to the general understanding of students' level of agreement on the important practices of sustainable agriculture and the knowledge level of this important field of agriculture.

The Sustainable Agriculture Research and Education program has been on the forefront advocating for farm practices that are profitable and good for the environment. It has been able to do this through research and provision of education grants. The National Research Council is the other agency that has been greatly involved in the promotion of sustainable agriculture curriculum (NRC, 2013). The Council has been instrumental in the distribution of instructional materials nationally to assist in integrating sustainable agriculture into high school agricultural education curriculum addressing topics including soil and water conservation, land use and air quality control (NCAE 2000; Muma, 2006).

Social Reconstruction ideologists uphold similar societal beliefs regarding the role of education in reconstructing society to keep it sustainable. They have confidence in the ability of educators to infuse knowledge to citizens in order to protect their environment and surroundings from destruction (McNeil, 2006). An undergraduate sustainable agriculture program relates well with social reconstruction theory. Social-reconstructionism assumes that the survival of our society is threatened by many problems. The theory proposes that the goals of any education system should include interests of individuals as well as those of the entire society. The most pressing societal needs should be the basis of curriculum development, teaching, learning and evaluation. The theory assumes that all individuals have the responsibility for the stewardship of the natural resources surrounding them. The theory further argues that most curricula lack universal learning objectives and content because they prioritize contextual problems in educational processes (McNeil, 2006). Institutions of higher education should move towards participatory and systemic learning for sustainable development. This action makes students appreciate, understand and think critically about complex environmental, social and economic problems.

This study undertook a wide investigation of students' knowledge and perceptions toward some of the environmental issues raised by Leeuwis (2000) and Al-Subaiee et al. (2005). Major environmental concerns today include soil degradation, erosion, water pollution, excessive use of chemicals, waste of water, decreasing ground water tables, destruction of wildlife natural habitats and insects' and pests' resistance to insecticide and pesticide (Leeuwis, 2000; Al-Subaiee et al., 2005). This study is also meant to arouse the interest among agricultural educators to look at these farming practices from a more holistic perspective when developing educational curriculum addressing sustainability. Integrating knowledge across the many disciplines in agriculture will help to provide solutions to agricultural issues that are informed by social science research (Osborne, 2011).

Materials and Methods

The instrument was comprised of two sections. The first section required students to provide their demographic information such as gender, college major, ethnicity, educational classification, the area they grew up in and age. The source where they gained most exposure to sustainable agriculture: high school, undergraduate courses and/or graduate courses was also included in this section. Section two of the survey was comprised of two sets of questions. The first set required students to rate their level of agreement with statements defining the important aspects of sustainable agriculture on a five-point Likert scale with 1= strongly disagree and 5 = strongly agree. The second set of questions asked students to rate their level of knowledge on twelve sustainable agricultural practices with 1 = no knowledge and 5 = high knowledge.

Selection of the twelve sustainable agricultural practices was guided by extensive review of the appropriate literature materials. Both plant and animal related practices were evaluated to control for any possible bias on the sampled student population. Studies that were instrumental in defining sustainable agricultural practices included: Borsari (2001); Borsari and Vidrine (2005); Conroy (2000); Walter and Reisner (1994). Conroy (2000) defined sustainable agriculture as a system guided by a positive time preference attitude that aim at meeting the basic needs of the present generation without sacrificing the ability of the available resources to satisfy the needs of the future generations.

To account for instrument reliability, a pilot test was conducted with a group of 16 students from the Department of Agriculture who did not appear in the random sample. All 16 students responded to the pilot test for a 100% response rate. The pilot test indicated a reliability coefficient of α = .93 and α = .94 for the two sets of questions on students' level of agreement on the important aspects of sustainable agriculture production and knowledge level of twelve sustainable agricultural practices. The instrument was deemed reliable and the data collection process began.

A list of the total number of students in the Departments of Agriculture and Geography was retrieved from the Administrative Assistant in each of the respective departments. A total of 281 students appeared in the Agriculture database and 219 in the Department of Geography. The sample population consisted of Agricultural Education graduate students and undergraduate

students majoring in Animal Science, Pre-vet, Agricultural Systems, Agriculture Teacher Certification, Horticulture, General Agriculture, Agribusiness and Resource and Environmental Studies. Email surveys were sent on January 26, 2011 to a total of 500 students. Each email contained an introduction from the researcher, an explanation of the survey, an explanation of the incentive drawing of a $25 Wal-Mart gift card and a link to the survey. A total of three reminder emails were distributed, as well as a fourth hard copy mailed instrument to increase response rate (Dillman, 2007).

Data was collected via Qualtrics software and was uploaded directly into an SPSS 13.0 data file. A total of 302 of the 500 students responded, yielding an overall response rate of 60.4%. Results of the survey were reported using frequencies and descriptive statistics. Demographic information obtained from section one as well as results from section two of the survey is discussed below.

Results and Discussion

Of the 301 student respondents, 156 (51.7%) were male and 145 (48.3%) were female. When examining student ethnicities, 236 (78.1%) were Caucasians, 42 (13.9%) Hispanic and the remaining 24 (7.3%) individuals were either African Americans or international students. The respondents were aggregated by major for investigation purposes. Seventy five (24.8%) of the students were majoring in Resource and Environmental studies, 43 (14.2%) General Agriculture, 40 (13.2%) Agribusiness and 38 (12.6%) Horticulture. Additional majors are included in Table 1. Students' major source of exposure to sustainable agriculture was also investigated. Approximately 152 (50.3%) of the students indicated courses taken at the university level as their main source of exposure to sustainable agriculture. The remaining group of students, (n=35), indicated high school and professional development courses as their major sources of sustainable agriculture knowledge (n=18).

The main sources of exposure discussed above alongside others solicited in the survey but not discussed here need to be further explored. This study's main objective was to disaggregate students' perceptions on sustainable agriculture based on their college majors. Additional investigation on the effect of ethnic background on the exposure to this important topic is therefore necessary.

Table 1. Participant Classification Based on Majors

College 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
Total	301	100

Overall means of students' level of agreement with statements about sustainable agriculture production were evaluated. As shown in Table 2, students were in general agreement that sustainable agriculture production promotes the well-being of the ecosystem (M = 4.28). Following closely was the statement that sustainable agriculture conserves natural resources (M = 4.27). Mean values for the other statements were as follows, sustainable agriculture promotes long-term land productivity (M = 4.25), allows farmers to sell products locally (M = 4.03) and promotes food safety (M = 4.03). The statement that sustainable agriculture assures profitable returns from farm enterprises scored the lowest mean (M = 3.47). This suggests that students were indifferent regarding the relationship between profitability and sustainable agricultural practices. Additional levels of agreement can be found in Table 2.

Table 2. Overall Means for Students' Level of Agreement with Sustainable Agriculture Production

Sustainable agriculture production:	*n*	*M**	*SD*
promotes the well-being of our ecosystem	276	4.28	.84
conserves natural resources	276	4.27	.80
promotes long-term land productivity	276	4.25	.84
allows farmers to sell products locally	276	4.04	.79
promotes food safety	276	4.03	.87
reduces ground water contamination	276	3.99	.90
benefits small-scale farmers	276	3.98	.93
increases farm income	276	3.49	.87
assures profitable returns	276	3.47	.86

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

Descriptive statistics were also utilized to determine students' level of knowledge on twelve sustainable agricultural practices. Means obtained indicated that students who participated in the survey believed themselves to be moderately knowledgeable on the selected sustainable agricultural practices. The overall means for all practices studied ranged between (M = 2.57) and (M = 3.46) which on a Likert-type scale represented a range between little knowledge and moderate knowledge. Students indicated the most knowledge on the use of animal manure as fertilizer (M = 3.46) while IPM generated the lowest mean (M = 2.57). Student knowledge on other sustainable farm practices was evaluated and results recorded in Table 3.

Table 3. 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 4. College Majors Level of Knowledge on Sustainable Agricultural Practices

		Use of animal manure		Crop Rotation		Reduced use of fertilizers		Genetically Modified Crops		Use of cover crops		Reduced use of herbicides	
Major[a]	*n*	*M*[b]	*SD*	*M*[b]	*SD*	*M*[b]	*SD*	*M*[b]	*SD*	*M*[b]	*SD*	*M*[b]	*SD*
AgedG	11	4.00 (1)[c]	0.89	4.00 (1)	1.83	3.82 (1)	0.87	3.55 (1)	1.04	4.00 (1)	1.00	4.00 (1)	0.63
Ansc	31	3.10 (9)	1.01	3.16 (7)	1.19	2.74 (9)	1.03	2.87 (9)	1.09	2.61 (8)	1.26	2.58 (9)	0.92
AnscPv	20	3.40(6)	1.05	3.00 (9)	1.26	2.95 (7)	1.04	3.15 (5)	1.35	2.50 (9)	1.32	2.80 (8)	1.24
GenAg	40	3.33 (7)	1.14	3.05 (8)	1.34	2.98 (6)	1.31	3.08 (6)	1.27	2.80 (7)	1.34	2.93 (6)	1.21
GenAgT	18	3.94 (2)	0.87	3.44 (3)	1.45	3.11 (4)	1.18	3.44 (2)	1.15	3.06 (5)	1.06	3.11 (5)	1.37
Agbm	36	3.25 (8)	0.94	3.31 (6)	1.01	2.92 (8)	0.86	2.89 (8)	0.95	3.14 (4)	1.02	2.83 (7)	0.91
AgbmH	38	3.55 (4)	0.98	3.34 (5)	1.07	3.53 (2)	1.22	3.21 (4)	1.36	3.50 (3)	1.13	3.45 (2)	1.08
AgbmAs	16	3.56 (3)	1.53	3.38 (4)	1.20	3.00 (5)	0.97	3.00 (7)	1.32	2.88 (6)	1.26	2.94 (4)	1.00
REnst	65	3.54 (5)	1.05	3.65 (2)	1.01	3.45 (3)	1.06	3.40 (3)	1.09	3.54 (2)	0.95	3.34 (3)	1.08

Taking the analysis one step further indicates a very noticeable knowledge gap in the scores between majors on the twelve sustainable agricultural practices. When examining Table 4, one can see that Agricultural Education majors had the highest score in all of the sustainable agricultural practices. Mean averages for this group of students ranged from M = 3.18 to M = 4.00, respectively, indicating at least some or moderate knowledge on the topics. Animal Science majors on the other hand, indicated having little to no knowledge on many of the sustainable agriculture topics. Compared to the other eight majors, the knowledge level of Animal Science majors ranked in last place in eight of the twelve sustainable agriculture practices. Table 4 ranks the knowledge levels of the remaining majors on the sustainable agriculture practices.

Summary

Agricultural education needs to address elements of emerging agriculture including sustainable production, processing, and marketing and distribution systems. Osborne (2011) underscored the importance of sensitizing the public about sustainable agriculture. He suggested an interdisciplinary approach that promotes sustainable agriculture right from the classroom to the field. Increased interdisciplinary research projects and promotion of graduate and undergraduate programs on sustainable agriculture will increase student interest and exposure in this important field of agriculture. Mean disparity across the selected college majors is a clear indication of lack of an interdisciplinary approach in studying sustainable agriculture topics. Researchers have advanced that sustainability education that infuses concepts that link social, economic and ecological systems allows students to understand and make a connection with real world problems involving agricultural production (Santone, 2003; Osborne, 2011).

Use of animal manure as a fertilizer obtained a relatively high mean (M = 3.46) across the entire population studied. Students' level of knowledge on crop rotation obtained (M = 3.36), the second highest mean. It was quite disappointing that the widely advocated practice of IPM generated the lowest mean (M = 2.57). 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 (Van den Berg and Jiggins, 2007). 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. 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) and Osborne (2011) proposed an interdisciplinary move to address issues regarding sustainability. He argued that interdisciplinary perspectives are crucial in reinforcing new forms of learning in solving complex problems on sustainability. According to Francis et al. (2003) sustainable agriculture is an interdisciplinary field of study which demands enormous effort from experts in different disciplines to address the existing societal and environmental problems in the agricultural and food system. Graduate students perceived themselves to be relatively more knowledgeable than the undergraduates on this topic as shown in Table 4. This concurs with the assertion made by Borsari and Vidrine (2005) that incorporation of topics relevant to sustainable agriculture, environmental science, policy and holistic management are made at the graduate level.

Based on findings related to the three research questions it is possible to make the following recommendations: (1) undergraduate agriculture curriculum needs to be improved to include more topics in sustainable agriculture, (2) interventions aimed at igniting learners' interest in this very important topic should be pursued, (3) 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 and (4) an educational system that integrates curriculum and instruction with concepts linking social, economic and ecological systems should be embraced.

Literature Cited

Al-Subaiee, S., E. Yoder and J. Thomson. 2005. Extension agents' perceptions of sustainable agriculture in the Riyadh Region of Saudi Arabia. Jour. International Agricultural Extension Education 12: 5–13.

Borsari, B. 2001. Sustainable agriculture: Its time has come. Jour. of College Science Teaching 90(5): 336-338.

Borsari, B. and M. Vidrine. 2005. Undergraduate agriculture curricula in sustainability: An evaluation across borders. Jour. of Sustainable Agriculture 25(4): 93-112.

Conroy, C.A. 2000. Reinventing career education and recruitment in agricultural education for the 21st century. Journal of Agricultural Education 41(4), 73-84

Dillman, D.A. 2007. Mail and internet surveys: The tailored design method. 2nd Ed. New Jersey: John Wiley and Sons, Inc.

Francis, C., G. Leiblein, J. Helenius, L. Salomonsson, H. Olsen and J. Porter. 2003. Challenges in designing ecological agriculture education: A Nordic perspective on change. American Journal of Alternative Agriculture 16(2): 89–95.

Keating, M., V. Bhavsar, H. Strobel, L. Grabau, M. Mullen and M. Williams. 2010. Engaging agriculture and non-agriculture students in an interdisciplinary curriculum for sustainable agriculture. NACTA Journal.

Leeuwis, C. 2000. Learning to be sustainable. Does the Dutch agrarian knowledge market fail? Jour. Agricultural Education and Extension 7: 79–92.

McNeil, J.D. 2006. Contemporary Curriculum: In thought and action. 6th Ed. New Jersey: Wiley.

Muma, M., R. Martin, M. Shelley and L. Holmes. 2010. Sustainable agriculture: Teacher beliefs and topics taught. Journal of Sustainable Agriculture 34: 439-459.

Muma, M.A. 2006. Sustainable agriculture and the perception of high school agriculture teachers in the North Central Region of the United States. Retrieved from http://proquest.umi.com/pqdlink?Ver=1&Exp=06-18-2016&FMT=7&DID=1216741141&RQT=309&attempt=1&cfc=1

National Council for Agricultural Education (NCAE). 2000. The reinventing agricultural education for the year 2020: Introduction to environmental science. Madison, WI: The National FFA Foundation

National Research Council (NRC). 2013. Toward sustainable agricultural systems in the 21st Century. Washington, DC: National Academy Press.

Osborne, E.W. 2011. Taking agricultural education to the next level. Journal of Agricultural Education 52 (1): 1-8 .

Robertson, G.P. and S.M. Swinton. 2005. Reconciling agricultural productivity and environmental integrity: A grand challenge for agriculture. Frontiers in Ecology and the Environment 3(1), 38-46.

Santone, S. 2003. Education for sustainability. Educational Leadership 61(4): 60- 63.

Van den Berg, H.and J. Jiggins. 2007. Investing in farmers - The impacts of farmer field schools in relation to integrated pest management. World Development 35(4), 663-686.

Walter, G. and A. Reisner. 1994. Midwestern land-grant university scientists' definitions of sustainable agriculture: A Delphi study. Am. J. Alt. Ag. 9(3), 109-121.

Williams, D.L. 2000. Students' knowledge of and the expected impact from sustainable agriculture. Jour. of Agricultural Education 41 (2): 19-24.