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Perceptions of Agriculture Teachers Regarding Education about Biomass Production in Iowa

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Abstract

With the growth of biorenewable energy, biomass production has become an important segment in the agriculture industry (Iowa Energy Center, 2013). A great workforce will be needed for this burgeoning biomass energy industry (Iowa Workforce Development, n. d.). Instructional topics in agricultural education should take the form of problems and questions faced by the agriculture industry itself (Phipps, Osborne, Dyer, & Ball, 2008). This study sought to determine the perceptions of agriculture teachers regarding biomass production education in Iowa. Results of this study indicated that teachers held strongly to moderately positive perceptions toward biomass production and teaching about biomass production. In addition, participations in workshops related to bioenergy were found to have a positive impact on teachers' perceptions regarding teaching about biomass production. Teachers indicated a need for in-service training on teaching about biomass production education. It is recommended that institutes, extension organizations and corresponding professional organizations hold more workshops and training programs related to biomass production education for teachers.

Keywords: biomass; energy; perceptions; agriculture teacher; teacher education

"Biomass energy has the potential to supply a significant portion of America's energy needs, revitalizing rural economies, increasing energy independence, and reducing pollution" (Union of Concerned Scientists, 2003, para. 3). Biomass is any biological material that can be used for energy (Biomass Energy Resource Center, 2013). As a renewable energy source, biomass can be directly combusted to produce heat or power, or be converted into biofuel, including bioethanol and biodiesel (Biomass Energy Resource Center, 2013). Some examples of biomass include wood chips, corn grain, corn stalks, soybeans, switchgrass, straw, animal waste and food-processing by-products (Iowa Energy Center, 2013). In Iowa, biomass energy production has made a considerable contribution to the local economy. The bioethanol industry of Iowa has produced more than 3.7 billion gallons annually and resulted in 74,000 new jobs (Iowa Energy Center, 2013). The bioethanol industry's economic output accounted for $6 billion of Iowa's Gross Domestic Product (GDP) (Iowa Corn Promotion Board, 2013). In addition, Iowa produced about 184 million gallons of biodiesel in 2012, and added $ 400 million of GDP in Iowa (Iowa Biodiesel Board, 2013). Iowa, with its significant agricultural industries, has led and will continue leading the way in developing and expanding the market for value-added, biomass-based fuels and chemicals (Iowa Energy Center, 2013). With this information as a background, there is a critical question: What will be the role of education in helping this segment of the agriculture industry to grow and prosper?

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Education is the essential foundation for the development of the biomass energy industry (Jennings & Lund, 2001). Agricultural education is presumed to cover the related topics for two reasons. First of all, a large workforce will be needed in Iowa and the Midwest region of the United States with the burgeoning biomass energy industry (Iowa Workforce Development, n.d.). In the National Research Agenda of the American Association for Agricultural Education, Doerfert (2011) advocated that agricultural education needs to provide the workforce to meet the growth of global food, fiber, and energy needs. In addition, agricultural educators ought to realize that instructional programs and student learning activities must reflect the dynamic and ever-changing industry of agriculture; the instructional topics take the form of problems and questions faced by the agriculture industry itself (Phipps, Osborne, Dyer, & Ball, 2008).

Secondly, science education has been encouraged to be integrated into agricultural education (Balschweid & Thompson, 2002). The United States Department of Agriculture (USDA) financially supported agricultural education programs to include more science education for better preparation of students' future careers in agriculture (Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, 1999). Hodson (2003) identified energy resource as one of the seven areas of science education that will benefit individual as well as the society's economy in the future. The topic of biomass energy production should be promoted in the science curricula (Hodson, 2003). Halder, Pietarinen, Havu-Nuutinen and Pelkonen (2010) indicated "the biomass energy system is a new and challenging topic including several socio-economic and environmental dimensions…" (p. 1233) and it demands more consideration in the education of young people. For the recognition of need in the area, the USDA and Sam Houston State University held a series of workshops for agriculture teachers and science teachers to promote sustainable energy education in K-12 schools (Vocational Agriculture Teachers Association of Texas, 2013).

In Iowa, several workshops related to biomass and biorenewable energy education have been held for agriculture teachers and/or science teachers of K-12 education by Cenusa Bioenergy (2013), Iowa Experimental Program to Stimulate Competitive Research (EPSCoR), and the National Science Foundation Engineering Research Center for Biorenewable Chemicals (CBiRC). Seemingly, some agriculture teachers have shown some interest in biomass as well as biomass production based on the feedback from those workshops (Humke, Paulsen, Han, & Ohde, 2013; Zeller, 2013). However, the total number of teachers who participated in those workshops was very limited. Moreover, there was no known study indicating agriculture teachers in Iowa had intentions of teaching about biomass in their agriculture courses. In addition, little is known regarding teacher preparation about biomass production education. Without identifying the teachers' perceptions and beliefs about teaching a subject, it is hard to provide teachers with corresponding support to improve teaching and learning in that subject (Susuwele-Banda, 2005). "…Within a single subject area, teachers' perceptions will influence a range of teaching skills, styles, models and approaches that comprise a teaching repertoire and this will provide a clear frame work for describing the teaching activities…"(Adu & Olatundun, 2007, p. 59). Literature (Leiby, Robinson, & Key, 2013; Feng, 2012; Kwaw-Mensah, 2008; Sikinyi, 2003) has shown that research on agricultural educators' perceptions of certain topics have benefited the agricultural education program as well as improved teaching that potential subject matter.

Theoretical Framework

This study was grounded in the Theory of Planned Behavior (TPB) (Ajzen, 1991). TPB is a model that helps to predicate people's behavior and understand the relationships between how the perceived beliefs, namely perceptions, affect human behavior (Lamm, Lamm, & Strickland, 2013). Sproule (1991) defined beliefs as a thought about objects, events, situations, and attitudes as a tendency to accept or reject a particular object, event or situation. Figure 1 presents the schematic of the TPB. According to the TPB (Ajzen, 1991; Ajzen, 2011), human behavior is

guided by three major perceived beliefs: 1) the subjective probability that the behavior will produce a given outcome (behavioral beliefs), 2) the perceived behavioral expectations of such important referent individuals or groups as the person's spouse, family, friends (normative beliefs), and 3) the perceived presence of factors that may facilitate or impede performance of a behavior (control beliefs).These three perceived beliefs, respectively, give rise to three key constructs: attitude toward the behavior, subjective norm, and perceived behavioral control (Ajzen, 2011). "As a general rule, the more favorable the attitude and subjective norm, and the greater the perceived control, the stronger should be the person's intention to perform the behavior in question" (Ajzen, 2011, p. 1). In addition to the intention, actual behavioral control may directly alter behavior, because many behaviors pose difficulties of execution that may limit volitional control (Ajzen, 2011). With the guidance of the TPB, this study embodied the three beliefs into three specific constructs for teachers' perceptions: 1) teachers' attitudes toward biomass production and teaching about biomass production; 2) social supporting and social pressures of biomass production and teaching about biomass production perceived by teachers; 3) barriers and challenges of biomass production and teaching about biomass production perceived by teachers. In this study, the investigations on teacher's perceptions are aligned with these three constructs. The three constructs also provided a general guidance for the development of research instruments used in this study.

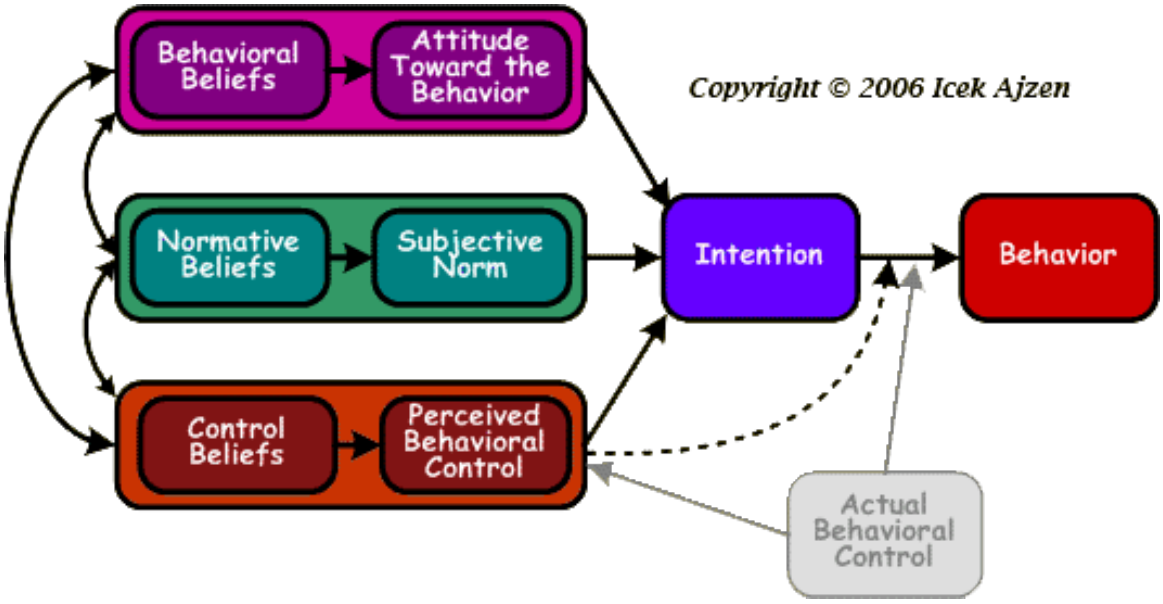

Figure 1. Schematic of Theory of Planned Behavior. Adapted from "Constructing a Theory of Planned Behavior Questionnaire," by I. Ajzen, 2011. Retrieved from: http://people.umass.edu/aizen/pdf/tpb.measurement.pdf. Copyright 2006 by Icek Ajzen.

Researchers in agricultural education and agricultural extension have widely used the TPB. Lamm, Lamm, and Strickland (2013) determined faculty members' intention to develop leadership within the land-grant system by using the TPB as the theoretical framework. Beckman and Smith (2008) developed their conceptualized framework for studying dietary behavior and garden knowledge based on the modification of the TPB. A similar study conducted by Myers and Washburn (2008), determined agricultural teachers' perceptions and attitudes toward the integration of science. Myers and Washburn (2008) elaborately employed the TPB as the theoretical framework, and their research provided a pattern for this research.

Purposes and Objectives

The purpose of this study was to determine the perceptions of secondary school agriculture teachers in Iowa regarding biomass production education. The following research objectives guided the study.

1. Describe the demographic characteristics of the agriculture teachers.
2. Describe the perceptions of agriculture teachers toward biomass production.
3. Describe the perceptions of agriculture teachers toward teaching about biomass production.
4. Determine the relationship between teachers' perceptions regarding biomass production and teachers' perceptions regarding teaching about biomass production.
5. Determine if a statistical model exists predicting teachers' perceptions regarding teaching about biomass production, from the demographics and past experience.

Methods

This statewide study used a descriptive survey research design. As part of a larger research project, this study used partial sections of the research instrument from the larger study. The survey questionnaire was developed and formatted to suit the purpose of the study after carefully reviewing similar studies by Feng (2012), Kwaw-Mensah (2008) and Sikinyi (2003). Three sections were included in the questionnaire: 1) Section one served to describe the perceptions of agriculture teachers toward biomass production. Twelve statements, including three reversed items, about biomass production were listed. Participants were asked to indicate the level of agreement with the statement on a five-point Likert type scale. 2) Section two was designed to describe the perceptions of agriculture teachers toward teaching about biomass production. Eight statements, including one reversed statement were used to assess the extent of positive or negative perceptions on teaching about biomass production. 3) The last section employed ten multiple choice questions and text entry questions to gather participants' demographic information and past experience including gender, age, years have been teaching, academic degree, levels taught, endorsement subjects, professional affiliations, experience of workshops related to bioenergy, and additional comments.

Validity is the most important consideration in developing a research instrument (Ary, Jacobs & Sorensen, 2010). To establish face validity and content validity for this survey instrument, a panel of experts consisting of five faculty and four graduate students reviewed and revised the survey instrument. The experts were from the Department of Agricultural Education and Studies, the Graduate Program in Sustainable Agriculture and the Department of Agronomy at Iowa State University. A pilot study was conducted with a small group of agriculture teachers (N=10) from Iowa. The testing adequacy, feasibility and reliability were verified by the pilot study. Cronbach's alpha determines the internal consistency in a survey instrument to gauge its reliability (Santos, 1999). The Cronbach's alpha reliability coefficient of section one of the survey instrument for this study was 0.785, and Cronbach's alpha reliability coefficient of the section two was 0.771. Nunnaly (1978) indicated 0.70 or higher to be an acceptable reliability coefficient.

The research population for this study consisted of all secondary agriculture teachers in Iowa. The population frame of the study was established by using the Iowa agriculture teacher directory (N=247). Israel (2013) indicated a mixed-mode of survey distribution can increase the response rate. A hard-copy of the questionnaire was distributed to teachers at the Iowa Association of Agricultural Educators' 2013 summer conference. An additional electronic-copy of the questionnaire was distributed by e-mail to all secondary school agriculture teachers in Iowa, and three reminders were implemented to maximize the response rate. There were 114 copies of

the questionnaire returned to the researchers. After cleaning the data, a total of 100 valid complete questionnaires were retained and resulted in a 40.5% response rate. Missing data was handled by Pairwise Deletion and Multiple Imputation with the suggestions of Schlomer, Bauman and Card's (2010) study. A response rate less than 85% could bring about threats to external validity of the study because of the non-response error (Lindner, Murphy, & Briers, 2001). The comparison between early respondents and late respondents was conducted to handle non-response error (Dooley & Lindner, 2003; Miller & Smith, 1983). Three variables including age, the level of agreement with the statement "students want to learn about biomass production", and the level of agreement with statement "biomass production contributes to the local economy" were accounted for by comparing early and late respondents with an independent samples t-test. No statistically significant difference was found at .05 level.

Findings

Objective 1

The first objective of this study was to describe the demographic characteristics of the agriculture teachers who participated the study. In this study, 66.7% (f = 64) respondents were male. The majority (73 %, f = 70) of the respondents' age ranged from 25 to 55, with an average slightly over 14 years of teaching experience. The largest percentage of teachers (70.8%, f = 68) acquired a bachelor's degree as the highest degree, and other teachers (29.2%, f = 28) acquired a master's degree. Slightly less than half (49.5%, f = 45) of the respondents taught both middle school and high school levels of agricultural education programs, and the remaining respondents (50.5%, f = 50) only taught at the high school level. In addition to teaching agriculture courses, more than half (54.7%, f = 47) of the respondents were endorsed to teach Biology, and 34.6% (f = 27) were state license endorsed to teach Science.

Objective 2

The second objective of this study was to describe the perceptions of Iowa agriculture teachers toward biomass production. The frequency distribution, means, and standard deviations of the teachers' perceptions towards statements regarding biomass production are shown in Table 1. The mean scores of all the statements were larger than the neutral score of 3.00, which indicated that respondents held moderately to strongly positive perceptions regarding biomass production. Further, a vast majority of the respondents (92%, f = 92) agreed to strongly agreed "using biomass for fuel can improve energy security". In addition, a majority of the respondents (86%, f = 86) agreed to strongly agreed with the statement that "biomass production contributes to the local economy", and 85% (f = 85) of the respondents agreed to strongly agreed with the statement that "biomass production contributes to the local job market". On the other hand, slightly less than half of the respondents (49%, f = 49) agreed to strongly agreed with the statement that "the principles of biomass production are easy to understand". Nearly half of the respondents (48%, f = 48) held neutral perceptions on the statement "the technology of biomass production is easy to practice" (M = 3.04, SD = .80).

Table 1

Frequency Distribution, Means and Standard Deviations of Agriculture Teachers' Perceptions regarding Biomass Production

Perception statement regarding biomass production	*f*						
	SD	D	N	A	SA	*M*	*SD*
Using biomass for fuel can improve energy security	0	0	8	66	26	4.18	.55
Biomass has helped lower the price of oil	2	8	41	36	13	3.50	.89
The federal government supports the development of biomass production	1	13	32	49	5	3.44	.82
Biomass production contributes to the local economy	0	1	13	61	25	4.10	.64
Biomass production contributes to the local job market	0	2	13	65	20	4.03	.64
Biomass production increases farmers' incomes	1	5	23	55	16	3.80	.80
The use of biomass as energy helps to reduce greenhouse gas emissions	1	7	31	52	9	3.61	.79
Biomass production does not hurt the soil*	0	15	27	49	9	3.52	.85
Biomass production does not hurt water resources*	0	10	30	49	11	3.61	.81
Biomass production does not threaten food security*	1	7	32	50	10	3.61	.80
The principles of biomass production are easy to understand	0	19	32	47	2	3.32	.80
The technology of biomass production is easy to practice	2	22	48	26	2	3.04	.80

Note. n=100. Original Scale: 1 = Strongly Disagree (SD), 2 = Disagree (D), 3 = Neutral (N), 4 = Agree (A) and 5 = Strongly Agree (SA). *Items were reverse coded.

Objective 3

The third objective of this study was to describe the perceptions of agriculture teachers regarding teaching about biomass production. The frequency distribution, means, and standard deviations for the statements are shown in the Table 2. The mean scores ranged from 3.06 to 4.01, which indicated, in general, the teachers had positive perceptions towards teaching about biomass production.

A majority of the respondents (80%, n = 80) agreed to strongly agreed with the statement that "teaching about biomass production is relevant to science education". In addition, 85% (n = 85) of teachers thought more training will be needed before teaching about biomass production. More than half of the teachers (64%, n = 64) agreed to strongly agreed with the statement that "teaching about biomass production will help students with their careers". In addition, 52% (n =

52) of the teachers agreed to strongly agreed with the statement that "teaching about biomass production will help students with future higher education". However, only 23% (n = 23) of the teachers believed students want to learn biomass production. A large proportion of the teachers (60%, n = 60) were neutral on the statement that "students want to learn about biomass production".

Table 2

Frequency Distribution, Means and Standard Deviations of Agriculture Teachers' Perceptions regarding Teaching about Biomass Production

Perception statement regarding teaching about biomass production	*f*					*M*	*SD*
	SD	D	N	A	SA		
Teaching about biomass production is relevant to science education	0	4	16	69	11	3.87	.64
Teaching about biomass production will help students with their careers	0	2	34	58	6	3.68	.61
Teaching about biomass production will help students with future higher education	0	4	44	47	5	3.53	.65
Teaching about biomass production is easy to integrate into the existing curriculum	5	7	41	42	5	3.35	.88
Students want to learn about biomass production	2	15	60	21	2	3.06	.72
Teaching about biomass production will be a challenge for the teacher	0	21	34	43	2	3.26	.81
More training will be needed for agriculture teachers before teaching about biomass production	0	3	12	66	19	4.01	.65
There is significant difference between teaching about regular crop (food) production and biomass production*	1	20	43	36	0	3.14	.76

Note. n=100. Original Scale: 1= Strongly Disagree (SD), 2= Disagree (D), 3=Neutral (N), 4= Agree (A) and 5= Strongly Agree (SA). *Items were reverse coded

Objective 4

The fourth objective of this study was to determine the relationship between the overall perceptions toward biomass production and the overall perceptions toward teaching about biomass production. The overall perception of each respondent regarding biomass production (OPB) was calculated from the arithmetic mean of every statement's score in section one of the questionnaire. The overall perceptions of each respondent regarding teaching about biomass production (OPT) was calculated from the arithmetic mean of every statement's score in section two of the questionnaire. In Table 3, the correlation matrix is displayed. The magnitude of relationships was determined by using Davis' (1971) conventions. A positive moderate

relationship was found between the overall perceptions regarding biomass production and the overall perceptions regarding teaching about biomass production (r =.441, p =.000).

Table 3

Inter-correlation between Overall Perceptions regarding Biomass Production and Overall Perceptions regarding Teaching about Biomass Production

		OPB	OPT
OPB	*r*	1	.441*
	p		.000
	n	100	100
OPT	*r*	.441*	1
	p	.000	
	n	100	100

Note. n =100. OPB = overall perceptions regarding biomass production; OPT = Overall perceptions regarding teaching about biomass production. r = Pearson correlation coefficient. Magnitude: .01 ≥ r ≥ .09 = Negligible, .10 ≥ r ≥ .29 = Low, .30 ≥ r ≥ .49 = Moderate, .50 ≥ r ≥ .69 = Substantial, r ≥ .70 = Very Strong (Davis, 1971). * p <.05.

Objective 5

Objective five of this study was to determine if a model existed predicting the overall perceptions regarding teaching about biomass production, from demographic information: (a) gender; (b) age; (c) years have been teaching; (d) the highest degree; (e) levels taught; (f) subjects endorsed to teach in addition to agriculture; (g) membership of a selected professional organization; and (h) attending any past workshop about biomass or bioenergy.

In order to accomplish this objective the researchers used multiple regression analysis. In conducting the multiple regression analysis, the dependent variable was each respondent's overall perceptions regarding teaching about biomass production (OPT) that was calculated in *Objective 3*. The independent variables included age, years have been teaching which were measured as a continuous variable on an interval scale. Other independent variables included the highest degree, levels taught, and subjects endorsed to teach in addition to agriculture. These independent variables were categorical in nature and had to be restructured as dichotomous variables in preparation for entry into the analysis. The other independent variables are neutrally dichotomous variables including gender, membership in a selected professional organization, and attending any past workshop about biomass or bioenergy. Stepwise entry of variables was used due to the exploratory nature of the study (Gaspard, Burnett, & Gaspard, 2011).

After reconstructing variables, there were eleven independent variables in total that consisted of two continuous variables and nine dichotomous variables, namely dummy variables (Suits, 1957). The two continuous variables are: 1) "*age*" and 2) "*years have been teaching*". The nine dichotomous variables are: 3) "*whether or not acquire a master's degree*", 4) "*whether or not teaching at middle school*", 5) "*whether or not endorsed to teach biology*", 6) "*whether or not endorsed to teach science*", 7) "*whether or not endorsed to teach chemistry*", 8) "*whether or not endorsed to teach psychics*", 9) "*whether or not endorsed to teach industrial art*", 10) "*whether or not holding a membership in Iowa Association of Agriculture Educators*", and 11)"*whether or not attended any past workshop about biomass or bioenergy* ".

Bivariate correlations between the demographic characteristics used as independent variables and the overall perceptions regarding teaching about biomass production were used to

identify the potential predictor variable(s) in the regression model (Nathans, Oswald, & Nimon, 2012). Among the eleven independent variables, only one independent variable, "*whether or not attended any past workshop about biomass or bioenergy"* (r = .318, p = .008), was found that significantly correlated with the dependent variable, "*the overall perceptions regarding teaching about biomass production*". All independent variables were tested for multicollinearity with other independent variables. No multicollinearity problem was found (*VIF* < 5).

Table 4 presents the results of the multiple regression analysis utilizing overall perceptions regarding teaching about biomass production as the dependent variable. The only variable which entered the regression model is "*whether or not attended any past workshop about biomass or bioenergy* ". The regression model was statistically significant with F = 7.557, p < .05.The effect size was reported by R squared (R^2 = .101) by the suggestion of Levine and Hullett (2006). After attending a past workshop related to biomass or bioenergy, the overall perceptions regarding teaching about biomass production increased .227 unit. The regression model for this study was illustrated as: the overall perceptions regarding teaching about biomass production = 3.340 + .227 attended any past workshop related to biomass or bioenergy. The model accounted for 8.8% of the variance in predicting the overall perceptions regarding teaching about biomass production of secondary school agriculture teachers in Iowa.

Table 4

Multiple Regression Analysis of the Overall Perceptions regarding Teaching about Biomass Production and Selected Demographic Characteristics

ANOVA

Source of Variation	*df*	*MS*	*F*	*p*
Regression	1	.711	7.557	.008
Residual	67	.094		
Total	68			

Model Summary

	b	*SE*	*β*	*p*
Intercept	3.340	.043		.000
Ps. experience [a]	.227	.083	.318	.008

Note. n = 69. R^2 = .101; Adjusted R^2 = .088. [a] whether or not attended a workshop related to biomass or bioenergy in the past.

Conclusions

The agriculture teachers in this study were a group of professionals led by middle aged experienced teachers, also encompassing young and beginning teachers. Most of the teachers were well educated and had a strong science background. Respondents' basic demographic information including gender, age, years have been teaching, levels taught, and endorsed subjects is consistent with past studies on agriculture teachers in Iowa by Feng (2012) and Koudinya and Martin (2010). Conclusions from this study can be generalized to the whole population of agriculture teachers in Iowa to some extent.

The teachers, on average, positively perceived biomass production. Aligning with the "three beliefs" in the TPB, their attitude toward biomass production were positive, but the levels of being positive varied by two divisions: their positive attitude toward biomass production's outcome for economy were much stronger than their positive attitude toward biomass production's impact on environment. The teachers strongly recognized the contributions that

biomass production has made to the economy. In addition, towards the potential drawbacks of biomass production, the teachers generally did not think they were an essential threat to the environment and food security. The teachers moderately perceived the subjective norm, namely social supporting and pressure of biomass production. The support from government was not strong enough to be recognized by every teacher, but a considerable number of the teachers perceived the support as very important. Behavioral control, namely barriers and challenges of biomass production was negatively perceived by the agriculture teachers. As recognized by Halder, et al. (2010), education about biomass production would bring challenges. The teachers did not think biomass production was easy to practice, which reflected a potential educational need for biomass production education. Grobbelaar (2010) and Wyman (1999) discussed many technical challenges were in front of biomass production including production costs, crop life-cycle environmental impacts, feedstock and off-take agreement, feedstock quality, co-products, and financing.

The teachers owned positive perceptions regarding teaching about biomass production. Their strong positive attitude toward teaching about biomass production attributed to identifying the career benefit and the educational benefit for students learning about this topic. This conclusion is in line with the proposal by Hodson (2003) that biomass energy production should be included in the curriculum for the benefits of students and society as well. However, there was uncertainty on the subjective norm, namely the social supporting and pressure of teaching about biomass production. The teachers did not know if students would be interested in learning about biomass production. Additional studies on student interest in this area might be needed. In addition, behavioral control, namely barriers and challenges of teaching about biomass production indicated the teachers have a need for training for teaching about biomass production, and it would be feasible to integrate biomass production education into the currently existing agriculture courses about crop production.

A moderate positive relationship was found between the teachers' perceptions regarding biomass and the perceptions regarding teaching about biomass production. Similar relationships were also found in the study by Sikinyi (2003) on biotechnology and teaching about integrating biotechnology into agriculture curricula, a study by Koudinya and Martin (2010) on food safety and a study by Kwaw-Mensah (2008) on livestock waste management. Both of the perceptions were positive, which reflects that the teachers were interested in biomass production and had the intention of teaching about this topic.

In general, the teachers had positive perceptions regarding teaching about biomass production, regardless of the differences in age, gender, and teaching experience. Participation in workshop activities related to biomass or bioenergy provided a positive influence on the perceptions of teaching about biomass production. Other demographic characteristics did not contribute any significant variance on the overall perceptions of teaching about biomass production. This conclusion is consistent with the workshop evaluation reports from Cenusa Bioenergy (2013).

Recommendations and Implications

This study focused on Iowa agriculture teachers' perceptions regarding biomass production education. However, renewable energy and bioenergy are much broader than biomass production. Therefore, future studies should be conducted on additional areas of renewable energy as well as bioenergy such as gasification, biochar, and environmental impacts (Cenusa Bioenergy, 2013). In addition, this study was a "snapshot" of the perceptions of the teachers. Research has shown that people's perceptions can be altered along with the dimension of time (Jones, 1976). A longitudinal study on the perceptions regarding biomass production education would fully illustrate the change in teachers' perceptions. Furthermore, the longitudinal study may also provide a more precise model to predict the perceptions. Though the statements in the

questionnaire in this study were built by the researcher and reviewed by the panel of experts under the guidance of the TPB, this study did not deeply explore unobserved latent variables. Conducting a factor analysis is recommended as the next step of this study to see how perceptions are constructed (Hoerr, et al., 2011).

As the teachers' strong need for training on the relevant topics before teaching about biomass production, research institutes, outreach extension organizations, and other corresponding professional organizations are recommended to develop and hold in-service training programs and workshops for teachers on teaching about biomass production. Teachers are also encouraged to attend more workshop activities focused on biomass or bioenergy topics, as the topics impact the agriculture industry and the related career available for young people studying agriculture (Iowa Workforce Development, n. d.; Vocational Agriculture Teachers Association of Texas, 2013).

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