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Perceptions of secondary school agriculture teachers regarding biomass production education in Iowa

Guang Han
Iowa State University

Perceptions of secondary school agriculture teachers regarding biomass production education in Iowa

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Guang Han

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Program of Study Committee:
Robert A. Martin, Major Professor
Wade W. Miller
Kenneth J. Koehler

Iowa State University

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ABSTRACT

With the boom of biorenewable energy, biomass production has become an important segment in agriculture industry (Iowa Energy Center, 2013). A higher 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 assess the perceptions of secondary 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 moderately positive perceptions toward teaching about biomass. In addition, seven topics related to biomass production education were identified with higher needs for future inservice training. Past experience of teachers participating in workshops about bioenergy was found to have a positive impact on teachers' perceptions regarding teaching about biomass production. In conclusion, teachers have a need for in-service training about biomass production education. It is recommended that institutes, extension organizations and corresponding professional organizations should hold more workshops about biomass production.

CHAPTER I. INTRODUCTION

Background and Setting

“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, para. 3, 2003). In Iowa, biomass energy production has made a considerable contribution to the local economy. The bioethanol industry of Iowa produced more than 3.7 billion gallons annually and resulted in 74,000 new jobs. 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 background, the question is what will be the role of education in helping this segment of the agriculture industry to grow and prosper.

Problem Statement

Education is an essential foundation for market development of the biomass energy industry (Jennings & Lund, 2001). 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).

Science education has been encouraged to be integrated into agricultural education (Balschweid & Thompson, 2002). The United States Department of Agriculture (USDA) has 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 resources as one of the seven areas of science education that benefit individuals 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 has demanded more consideration in the education of young people. In 2013, 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). In addition, some agriculture teachers from secondary schools in Iowa have shown some interest in biomass as well as biomass production based on the feedback of those workshops (Humke, Paulsen, Han, & Ohde, 2013; Zeller, 2013). However, the total number of teachers who participated in those workshops was only a small proportion of all the agriculture teachers in Iowa.

Need for the Study

There was no known study that indicated Iowa agriculture teachers have the intention of teaching biomass and biomass production in their agriculture courses. Without understanding the teachers' perceptions and beliefs about teaching a subject, it is hard to provide teachers with corresponding support to improve teaching and learning (Susuwele-Banda, 2005). "…Within any 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 (Feng, 2012; Leiby, Robinson, & Key, 2013; Kwaw-Mensah, 2008; Sikinyi, 2003) has shown that research on agricultural educators' perceptions of certain topics has benefited the agricultural education program as well as improved teaching that subject matter. In addition to the perceptions, the factors underlying teachers' perceptions are important to teacher educators to develop the in-service education program. McCaslin and Torres (1992) indicated without knowing the factors underlying teachers' perceptions toward a subject, teacher educators lack important information to plan, design, and implement in-service programs.

Purpose and Objectives

The purpose of this study was to assess the perceptions of secondary school agriculture teachers in Iowa regarding biomass production education and the teachers' in-service needs regarding biomass production education. The following research objectives guided the study:

1. To describe the perceptions of agriculture teachers regarding biomass production.
2. To describe the perceptions of agriculture teachers regarding teaching about biomass production.
3. To identify the biomass production topics needed by agriculture teachers through in-service training.
4. To identify the teaching methods and tools frequently used by agriculture teachers.
5. To determine the relationship between the overall perceptions regarding biomass production and the overall perceptions regarding teaching about biomass production.
6. To determine if a model exists predicting the overall perceptions regarding teaching about biomass production, from demographic information: (a) gender; (b) age; (c) years of teaching experience; (d) the highest degree; (e) levels taught; (f) subjects endorsed to teach in addition to agriculture; (g) membership of a selected professional organization; (h) attending any past workshops about biomass or bioenergy.

7. To identify factors underlying agriculture teachers' perceptions toward biomass production education.
8. To determine the proportion of variance in the teachers' perceptions that can be explained by these factors.

Significance of the Study

Literature has shown that the belief and perceptions of teachers have powerful impact on teaching (Adu & Olatundun, 2007; Tarman, 2012). The investigation on the teachers' perceptions regarding biomass production education in this study would provide policy makers with important information to decide if a biomass production related course should be added into the agriculture education programs in secondary schools.

As school-based agricultural education programs continue to grow, the supply of highly qualified teachers is critical (Kantrovich, 2007). Utilizing the findings from this study, agriculture teacher educators will be able to make in-service and/or pre-service training plan about the biomass production education including curriculum development, instruction methods, and teaching strategies.

Definition of Termers

Biomass is any biological material that can be used for energy (Biomass Energy Resource Center, 2013). Biomass typically refers to organic materials such as various plants and grains, crop waste, trees, wood wastes and animal wastes. 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). 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).

Biomass production namely is the production of biomass. In Iowa, available biomass resources include commodity crops, energy crops such as switchgrass, woody perennials, animal by-products such as manure, and agriculture residues & other waste (Brown, 1994).

Renewable energy is energy that is generated from natural processes that are continuously replenished. This includes sunlight, geothermal heat, wind, tides, water, and various forms of biomass. This energy cannot be exhausted and is constantly renewed (Penn State Extension, 2014).

Biofuels: Unlike other renewable energy sources, biomass can be converted directly into liquid fuels - biofuels - for our transportation needs (cars, trucks, buses, airplanes, and trains). The two most common types of biofuels are ethanol and biodiesel. Other biofuels include methanol and reformulated gasoline components. Methanol, commonly called wood alcohol, is currently produced from natural gas, but could also be produced from biomass (Renewable Energy World, 2014).

Bioethanol is an alcohol, the same found in beer and wine. It is made by fermenting any biomass high in carbohydrates (starches, sugars, or celluloses) through a process similar to brewing beer. Ethanol is mostly used as a fuel additive to cut down a vehicle's carbon monoxide and other smog-causing emissions. But flexible-fuel vehicles, which run on mixtures of gasoline and up to 85% ethanol, are now available(Renewable Energy World, 2014).

Biodiesel is made by combining alcohol (usually methanol) with vegetable oil, animal fat, or recycled cooking greases. It can be used as an additive to reduce vehicle emissions (typically 20%) or in its pure form as a renewable alternative fuel for diesel engines (Renewable Energy World, 2014).

Agricultural Education is a program of instruction in and about agriculture and related subjects. It has been offered in elementary schools, middle schools, secondary schools and postsecondary institutes. Subjects included are those of less than the four-year college level in plant and animal production, supporting biological and physical sciences, horticulture, natural resources, and environmental technology, mechanics, forestry food processing and other emerging subjects related to agriculture (Talbert, Vaughn, Croom, & Lee, 2007).

Agriculture teachers are defined as the instructors who teach agricultural education programs.

Perception is one of the major sources of our acquisition of knowledge about the world, is our sensory experience of the world around us and involves both there cognition of environmental stimuli and actions in response to these stimuli. Through the perceptual process, we gain information about properties and elements of the environment that are critical to our survival. Perception not only creates our experience of the world around us; it allows us to act within our environment (Cherry, 2010; Maund, 2003).

Summary

This chapter provided an overview of the whole study. As biomass industry boomed in Iowa, a large workforce was needed for the further development of this industry (Iowa Workforce Development, n.d.). In addition, biomass has been recognized as a bridge linked between agriculture and science education (Vocational Agriculture Teachers Association of Texas, 2013). However, the teachers' perceptions regarding biomass production as well as teaching about biomass production were unknown prior to this study. This study was to assess the perceptions of secondary school agriculture teachers in Iowa regarding biomass production education and the teachers' in-service needs regarding biomass production education, and eight research objectives were formed.

CHAPTER II. REVIEW OF LITERATURE

This study sought to assess the perceptions of secondary school agriculture teachers regarding biomass production in Iowa. To thoroughly investigate the information, and make it valuable for teacher educators, educational researchers, and teachers themselves, eight specific research objectives were developed into the following:

9. To describe the perceptions of agriculture teachers regarding biomass production.
10. To describe the perceptions of agriculture teachers regarding teaching about biomass production.
11. To identify the biomass production topics needed by agriculture teachers through in-service training.
12. To identify the teaching methods and tools frequently used by agriculture teachers.
13. To determine the relationship between the overall perceptions regarding biomass production and the overall perceptions regarding teaching about biomass production.
14. To determine if a model exists predicting the overall perceptions regarding teaching about biomass production, from demographic information: (a) gender; (b) age; (c) years of teaching experience; (d) the highest degree; (e) levels taught; (f) subjects endorsed to teach in addition to agriculture; (g) membership of a selected professional organization; (h) attending any past workshops about biomass or bioenergy.

15. To identify factors underlying agriculture teachers' perceptions toward biomass production education.
16. To determine the proportion of variance in the teachers' perceptions that can be explained by these factors.

This chapter focuses on the review of literature that provided a foundation to complete the research objectives for this study. The review of the literature focused on three concerns: significance of biomass production and use in agriculture; the educational needs of biomass production and use is linkage and agriculture literacy; the need to gather teachers' ideas and perceptions regarding adding biomass production to the courses in agricultural education.

The Use of Biomass for Energy

Energy plays a vital role in our everyday livers. As Demirbas (2009) concluded "…energy is one of the vital inputs to socio-economic development of any country" (p. 1). In the past, the strong economy of U.S. has been propped up by the abundant and stable energy source, such as petroleum and other fossil fuels (Bungay, 1980). However, the United States met a serious energy challenge, because short supply of fossil fuels in world-wide and cheap energy were gone, (Revkin, 2011). Policy makers have foreseen this challenge, and many renewable energy sources have been developed (Pound, 2010). Major renewable energy sources include: hydropower, biomass, geothermal, solar, wind, and wave (Demirbas, 2009). Among these renewable energy sources, the majority do not represent combustible energy sources expect for biomass. With the essence of being combustible, biomass can be used to heat and power generation, pyrolysis, gasification, digestion etc. (Demirbas, 2009).

Biomass is organic material that has stored sunlight in the form of chemical energy. All biomass is produced by green plants converting sunlight into plant material through photosynthesis (Hall etal., 1993). According to Demirbas (2009), three main reasons can explain why biomass has been and continues to be an important renewable energy source:

> First, it is a renewable resource that could be sustainably developed in the future. Second, it appears to have formidably positive environmental properties, reduced Greenhouse Gas emissions, possibly reduced NO_x and SO_x depending on the fossil-fuels displaced. Third, it appears to have significant economic potential provided that fossil fuel prices increase in the future (p.34).

Yokoyama and Matsumura (2008) indicated that there are two major pathways for using biomass as energy: 1) Directly combust the biomass feedstock such as wood, agriculture waste, and energy crop to generate heat and power. Electricity is able to be produced by this pathway; 2) Biomass can be converted into other forms of energy products through advanced gasification and pyrolysis technologies. Common energy products from biomass include: bioethanol, biomethanol, bio-oil, biodiesel, Fischer-Tropsch products, biogas, biohydrogen (Demirbas, 2009). After knowing the reasons why biomass has become an important renewable energy, and how it can be utilized by people, it is necessary to know the sources of biomass.

Sources of Biomass

The environmental and Energy Study Institute (2013) provided a comprehensive and specific definition of biomass:

> Biomass is defined as living or recently dead organisms and any byproducts of those organisms, plant or animal. The term is generally understood to exclude coal, oil, and other fossilized remnants of organisms, as well as soils. In this strict sense, biomass encompasses all living things. In the context of biomass energy, however, the term refers to those crops, residues, and other biological materials that can be used as a substitute for fossil fuels in the production of energy and other products. Living biomass takes in carbon as it grows and releases this carbon when used for energy, resulting in a carbon-neutral cycle that does not increase the atmospheric concentration of greenhouse gases (para. 1).

In addition to the precise definition of biomass, the environmental and Energy Study Institute (2013) also identified the most common and/or most promising varieties of biomass feedstocks can be used to produce biomass for energy use:

1. Starch crops include: sugar cane, corn, wheat, sugar beets, industrial sweet potatoes, etc.
2. Agricultural residues include: corn stover, wheat straw, rice straw, orchard prunings, etc.
3. Food wastes include: waste produce, food processing waste, etc.
4. Forestry materials include: logging residues, forest thinnings, etc.
5. Animal byproducts include: tallow, fish oil, manure, etc.
6. Energy crops include: switchgrass, miscanthus, hybrid poplar, willow, algae, etc.
7. Urban and suburban wastes include: municipal solid wastes, lawn wastes, wastewater treatment sludge, urban wood wastes, disaster debris, trap grease, yellow grease, waste cooking oil, etc. (para. 3).

From the list above, it is easily to recognize that the majority of biomass feedstock comes from the agriculture industry. The same conclusion can be verified through a report from U.S. Energy Information Administration. This report identified the raw inputs of biomass feedstock in U.S. as: corn, soy, other seed crops, livestock, forestry, energy crops, and municipal solid waste (Newell, 2011). In addition to the domestic opinions, European Commission's (2010) research also indicated that agriculture is the key for a genuine, large expansion of biomass supply.

In summary, the agriculture industry has been identified as the foundation for the supply chain of biomass energy (McElroy, 2009). The next section will focus on the production of biomass in agriculture.

Biomass Production in Agriculture

The production of biomass from agriculture is divided into two categories: the food-based portion of crops and the nonfood-based portion of crops. A publication about biomass production from the National Association of Conservation Districts by Ashton, McDonell and Barnes (2009) indicated:

> The food-based portion of crops is the part of the plant that is either oil or simple sugars. Rapeseed, sunflower, soybeans, corn, sugarcane, and sugar beets are all examples of this type of agricultural biomass. The sugar from corn, sugar beets, and sugar cane are commonly fermented to produce ethanol. Oilseed crops such as rapeseed, sunflower, and soybeans can be refined into biodiesel (p. 17).
>
> The nonfood based portion of crops is the part of the plant that is commonly discarded during processing for food production. This category includes materials such as corn stover; wheat, barley, and oat straw; and nutshells. Stover and straw are fermented into ethanol. Nutshells are typically refined into biodiesel or combusted for heat. due to the important

function of crop residues in erosion protection and overall soil quality, care must be taken on a site-by-site basis to ensure sustainability (p. 17). Perennial grasses are grasses that have a life cycle of several years. some examples include big bluestem and switchgrass. The advantage of perennial grasses is that they have a low nutrient demand, a large geographical growing range, and high net energy yields. Perennial grasses are pretreated to break down cellulose and then fermented into biofuels such as cellulosic ethanol (p. 18).

Beef cattle, dairy cattle, hogs and poultry produce manure, which can be used to produce energy. Manure is typically categorized as a liquid, slurry (a mix of liquid and solids), or solid. In its solid state, manure can be burned for heating and cooking or to produce a gas for energy production as a slurry, manure releases methane (CH4), which can be captured to produce heat, power, electricity, and biofuels (p. 18).

Biomass in Iowa

Biomass has become an indispensable segment of the agriculture industry in Iowa (Iowa Energy Center, 2013). The Iowa Renewable Fuels Association reported in 2012, that the biomass energy products, namely, biodiesel and bioethanol accounted for nearly $5.5 billion or 4 percent of Iowa’s Gross Domestic Product (GDP); generated $ 4 billion of income for Iowa households; and supported nearly 60,000 jobs throughout Iowa (Urbanchuk, 2013).

Iowa has a remarkable reputation of biomass production nationwide. Within the United States, Iowa is the leading bio-ethanol producing state with a production capacity of 12.5 hm^3 representing almost a third of the US ethanol capacity and produced over 2.5 times more production capacity than the number two domestic producer, Nebraska (BBI International, 2009). In addition, the U.S. Energy Information Administration (2013) recognized Iowa as the leading ethanol-producing state in the nation; the second largest biodiesel production state; one of the top three states with the highest percentage of total in-state electricity generation from non-hydroelectric renewable energy resources.

Three primary advantages of Iowa's leading position in biomass production in the U.S. include: 1) plentiful natural renewable resources; 2) cutting-edge technology support from research institutes; and 3) supportive policies and regulations.

Plentiful natural renewable resource

Renewable resources provide 91.69% of Iowa's energy production, totaling 539,707 billion BTUs. This is 7.16% of total U.S. renewable energy production (U.S. Department of Energy, 2014). The U.S. Energy Information Administration (2013) concluded that Iowa's plentiful cornfields provide the feedstock for over 40 ethanol plants located in the state. Iowa has several cellulosic ethanol plants under development that will use agricultural waste including corn stover (the stalk, leaf, cob and husk left after harvest) or corn kernel fiber; an existing corn ethanol plant has recently been converted to a cellulosic ethanol plant that processes municipal solid waste. Iowa also has over a dozen biodiesel plants with a productive capacity of almost 320 million gallons per year.

Cutting-edge technology supports from research institutes

Iowa is committed to biomass research. The Iowa Energy Center has created the Biomass Energy CONversion facility (BECON) to focus on development of Iowa's abundant biomass resource potential (U.S. Energy Information Administration, 2013). The Bioeconomy Institute (BEI) at Iowa State University seeks to advance the use of biorenewable resources for the production of chemicals, fuels, materials and energy. The Institute will assure Iowa's prominence in the revolution that is changing the way society obtains its essential sources of energy and carbon (Iowa State University, 2013).

Supportive policies and regulations

Iowa's energy policies and regulations promote energy efficiency and renewable resources. In addition to several energy efficiency standards, the Mandatory Utility Green Power Option requires all electric utilities operating in Iowa, including those not rate-regulated by the Iowa Utilities Board, to offer green power options to their customers (U.S. Energy Information Administration, 2013). State regulations also require Iowa's two investor-owned utilities to own or to contract for a combined total of 105 megawatts of renewable generating capacity and associated production from generating facilities designated by the utilities and approved by the Iowa Utilities Board (U.S. Energy Information Administration, 2013).

At this moment, as summarized by Lee & Lavoie (2013), the development of biofuel refinement technology has three generations of different types of biomass:

1. First-generation biofuels are directly related to a biomass that is generally edible.

2. Second-generation biofuels are defined as fuels produced from a wide array of different feedstock, ranging from lignocellulosic feedstocks to municipal solid wastes.
3. Third-generation biofuels are, at this point, related to algal biomass but could to a certain extent be linked to utilization of CO2 as feedstock (p. 6).

The production of biomass in Iowa has mainly been dominantly for the first generation of biofuels (Carriquiry, Du, & Timilsina, 2011). The second biofuel generation, namely cellulosic biofuel, is currently on the track for commercialization and three cellulosic biofuel refinery projects have been/ are being built in Iowa by three companies: Poet-DSM, DuPont Industrial Biosciences, and Fiberight biorefinery (Lane, 2012). Although the third generation biofuel, algal biofuel, is still in the research stage, local government organizations have provided 2 million dollars for algae fuel project and several algal biofuel energy companies started their business in Iowa.

Iowa has led the production of biomass across the nation. The biomass production for the bioenergy market has a much shorter history than the traditional grain and livestock production for the food market. Therefore, it is necessary to discuss the existing and potential challenges faced by producers, researchers, and policy makers.

Challenges of Biomass Production

Food Security

The first challenge is worldwide food security. A report from the Food and Agriculture Organization of the United Nations (FAO) concluded that biofuels have been a major factor contributing to the rapid price increases during the past several years in the international grain markets (Rosegrant, 2008). Higher food prices reduce the access to food, which has possible long-term, irreversible consequences for health, productivity, and well-being—particularly if higher prices lead to reduced food consumption by infants and preschool children (Rosegrant, 2008). The Guardian, a British prestigious daily newspaper, indicated that biofuels have forced global food prices up by 75% according to a confidential report from the World Bank (Chakrabortty, 2008). Chakrabortty (2008) summarized three main ways the production of biofuels has distorted food markets: First, it has diverted grain away from food to fuel, with over a third of the corn in the United States now used to produce ethanol and about half of the vegetable oils in the European Union going towards the production of biodiesel; second, farmers have been encouraged to set land aside for biofuel production and cause insufficient farm land for food production; third, it has sparked financial speculation in the grain market, driving prices higher.

The challenge for food security is mainly, but not exclusively caused by the broad adoption of first generation biomass: grain. Therefore policy makers and scientists are currently devoted to the commercialization and research of the second generation biomass: cellulosic biomass as well as the third generation biomass: algal biomass. However, the producers of the newer generation biomass face more challenges from farming strategies, marketing, and environmental impact.

Farming strategies

The technology of second generation biomass refinement allows producers have a wide variety of crops for biomass production. Corn and soybeans are not the only biomass crops that can be grown by producers in Iowa. Researchers have developed many cropping systems for the production of biomass including annual species of plants:

triticale, sorghum-sudangrass, and crotalaria, as well as some perennial species of plants: switchgrass, indiangrass, eastern gamagrass and big bluestem (Schulte-Moore, Hall, Moore, Heaton, & Hallam, 2012). Those cropping systems have a comprehensive carbon cycle and prevention of soil erosion and nitrogen losses which is hardly achieved in corn-soybean system (Schulte-Moore, Hall, Moore, Heaton, & Hallam, 2012). Producers may need to be more informed and trained before they decide to adopt the new cropping systems. In addition, harvesting the cellulosic biomass requires removal of plant residues, for instance, corn stover. Producers are concerned about how the simultaneous harvest of grain and stover will affect grain harvest productivity, how the harvesting of stover will affect the soil, how much and when the residues should be harvested (Shinners, 2009). Further, the storage and transportation of cellulosic biomass is different from grain. Some standards including moisture, nitrogen (N), potassium (K_2O), phosphorus (P_2O_5), sulfur, ash content and gross energy were used by buyers to judge the biomass (Cecava, 2010). To meet those standards, producers may need to learn a complete education about the correct storage and transportation. Other farming strategies for biomass production including planting annual crops, establishing perennial plants, soil amendments, and pest control are different from grain production.

Environmental impact

Meyer (2010) conducted research on biomass' impact on the environment, and his research indicated that increased biomass production could have considerable consequences on water consumption and biodiversity. For example, a study in California found life-cycle water consumption for biofuel production is estimated to be up to 1000 times that of gasoline due to cultivation that consumes over 99 percent of life-cycle water use for agricultural biofuels (Fingerman et al., 2010). Large quantities of water are needed to grow the biomass crops and also because water pollution is exacerbated by agricultural drainage containing fertilizers, pesticides, and sediment (Dominguez-Faus et al., 2009).The impact of biofuels on biodiversity is also extensive; it is argued that biofuel crops are best described as invasive species, which will compromise biodiversity of both plant and animal life (Barney & DiTomaso, 2010). Research has shown that vertebrate diversity and abundance are generally lower in biofuel crop habitats relative to the non-crop habitats that these crops may replace (Fletcher et al, 2010). How to make biomass production a more environmentally friendly process is a critical conservation question (Edwards et al., 2010). The solution to water consumption may be through the cultivation of a select group of low-water-consuming crops, the solution to preserving biodiversity may be through cultivation of crops having a lower diversity effect (Meyer, 2010).

Another environmental concern is the Greenhouse Gas (GHG) emissions from the use of biomass and the production of biomass based energy products including biofuel. Searchinger, et al.(2008) used a worldwide agricultural model to estimate emissions from land use change, and found that corn-based ethanol nearly doubles greenhouse emissions over 30 years and biofuels from switchgrass, if grown on U.S. corn lands, increase emissions by 50%. The possibility of reduced GHG emissions, especially relative to fossil fuels, is one benefit of using biomass to make renewable electricity and fuels. However, the GHG-intensity of biomass-derived fuels and electricity is highly dependent on how the biomass is obtained and used (Curtright, Johnson, Willis, & Skone, 2012).

Market development

First generation biomass is based on grain, and so is the market: the traditional commodity market. As the downsides of the first generation biomass have been recognized by policy makers, the second and third generation biomass have started to be used by biofuel refineries and the cellulosic biomass (Khanna, Chen, Huang, & Onal, 2011). Currently, the commercialization of second generation biomass is growing fast. For instance, DuPont, a company, invested to build largest commercial-scale cellulosic biorefineries in the world in Nevada, Iowa (Rosen, 2012). The company has developed a cooperation model to collect corn stover from farmers in Iowa. However, the complete supply chain of cellulosic biomass is not well built yet, and uncertainties of this market still exist (Berndes & Smith, 2013). In addition, though scholars have provided positive predictions about the commercialization of algal biofuel (Singh & Gu, 2010), no existing literature indicated the market of algal biomass has been or will be developed.

The challenges from food security, farming strategies, environmental impact, and market development are the barriers to further develop biomass production. Education is a critical way to overcome barriers.

Educational Needs of Biomass Production

Education has played an irreplaceable role in the progress of science and technology. As it has been shown, the development of biomass is very important and full of challenges, it is wise to discover what contributions education can provide to development. Jennings and Lund (2001) identified that education is an essential foundation for the development of the biomass energy industry.

Workforce development and job creation

In the literature, Meyer (2010) analyzed the job opportunities that the biomass energy industry will bring.

> In these times of economic hardship, job creation and government spending are particularly critical issues. As biofuel industries continue to develop, the primary driving forces are more likely to be employment potential and job creation (Domac et al., 2005). The employment potential for the global biofuel industry is significant. On average, biofuels require about 100 times more workers per joule of energy content produced than the highly capital-intensive fossil fuel industry (Renner & McKeown, 2010). And as global petroleum output declines, fossil energy jobs may become scarcer, allowing a shift to the labor-intensive biofuel industries. The biofuels industry needs farmers and also requires a broad range of expertise, including engineers, scientists, policy makers, economists and laborers. It is estimated that in the United States, all types of biomass operations together employed about 136,999 people directly in 2006 and another 310,000 in supplier industries (Renner & McKeown, 2010). There has also been an increase in indirect employment—that is, jobs generated within the economy as a result of expenditures related to the sale of biomass and biofuels (para.4-5).

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).

Science technology engineering and mathematics (STEM) education

The Oregon Institute of Technology (2013) described the needs of STEM education as:

> Education in science, technology, engineering and math (STEM) has received increased attention in recent years due to fears that a failure to produce enough students with high-quality STEM skills will hamper America's ability to compete in an increasingly global economy. States are beginning to evaluate their own education systems and considering strategies that will improve the overall quality of education in order to prepare students for jobs in a 21st Century workforce (para. 1-2).

As early as 2008, Kuenzi (2008) found that: "…a large majority of secondary school students fail to reach proficiency in math and science, and many are taught by teachers lacking adequate subject matter knowledge" (Para. 1). Policy makers are considering policies that would increase the rigor of high school education, address the problem of losing students who were college-bound, and improve the quality of the teaching and leadership within a school (Kuenzi, 2008).

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 benefit individuals 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 demanded more consideration in the education of young people. In 2013, 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).

Biomass energy education in the Future Farmers of America (FFA) program

A brief introduction can be found in on the official website of the National FFA Organization (2014):

> The Future Farmers of America (FFA) was founded by a group of young farmers back in 1928. Their mission was to prepare future generations for the challenges of feeding a growing population. They taught us that agriculture is more than planting and harvesting-- it's a science, it's a business and it's an art. FFA continues to help the next generation rise up to meet those challenges by helping its members to develop their own unique talents and explore their interests in a broad range of career pathways. So today, we are still the Future Farmers of America. But, we are the Future Biologists, Future Chemists, Future Veterinarians, Future Engineers and Future Entrepreneurs of America, too (para. 1-3).

The latest statistics indicated that 579,678 students are currently enrolled as FFA members, aged 12□21 in all 50 states, Puerto Rico and the U.S. Virgin Islands (National FFA Organization, 2014). With the strong impact on students who are interested in agriculture, FFA constantly improves the educational programs and updates the topics. Alternative energy including biomass energy has become a growing area of agriscience education within FFA's programs (National FFA Organization, 2014). Adams (2009), encouraged FFA members to have a curriculum about biorenewable energy as designed by the Renewable Fuels Association and the Renewable Fuels Foundation. Adams (2009) indicated that:

> The curriculum was to provide FFA members – many who already have an understanding of agriculture and other related industries – with details about the nature of the renewable fuels industry today. The curriculum focuses on the ethanol production process, the benefits of ethanol production, the interplay between renewable fuels and agriculture, and wide range of other issues. The lessons are available through the Team Ag Ed Learning Center, a website designed to provide agriculture teachers with new and exciting instructional materials, tools and resources (para. 5).

Biomass energy education in public affairs education

Public affairs, including energy issue, are always included by citizenship education, and the Economic Development Commission of Arkansas (2010) indicated that:

> Teaching our youth about energy issues is perhaps as important as teaching them grammar or history. As the next generation of energy users, effective education offered early can help our students choose energy sources and behaviors that will benefit everyone by creating a sustainable energy future. By teaching the next generation about wise energy choices, we can help alleviate negative impacts associated with renewable energy, such as: homeland security, dependence on foreign oil, impacts of energy use on society, energy conservation, global warming, environmental degradation, health, economy, pollution (para. 1).

Role of Agricultural Education

The textbook edited by Phipps, Osborne, Dyer, & Ball (2008) provided a solid foundation to understand what agricultural education is and what agricultural education program does:

> Agricultural education may be defined as systematic instruction in agriculture and natural resources at the elementary, middle school, secondary, postsecondary, or adult levels for the purpose of (1) preparing people for entry and advancement in agricultural occupations and professions, (2) job creation and entrepreneurship, and (3) agricultural

> literacy. The first two purposes involve education in agriculture, while the latter addresses education about agriculture. Education about agriculture generally includes occupational or career awareness, exploration, orientation and preparation, depending upon the age of the students enrolled. In addition, agricultural education in secondary schools and community colleges can provide a sound basis for further study and preparation for professional careers in agriculture and natural resources after graduation. Education in agriculture may include a vocational, practical arts, consumer, literacy, and therapy course and learning experiences and learning experiences. Agricultural education in the secondary schools has also played an important role in enhancing student achievement in the core subject areas, particularly science (p. 3-4).
>
> The instructional components of agricultural education programs include classroom instruction, supervised agricultural experience (SAE) programs, laboratory instruction, and student leadership development through participation in programs and activities of the National FFA Organization. As industry practices, educational trends and priorities, and student characteristics have changed over the years, the relative proportion of instructional time dedicated to each of these four components has varied (p. 5).

The explanation of Phipps, Osborne, Dyer, & Ball (2008) on agricultural education is consistent with the recommendations for education in and about agriculture by National Research Council (1988): 1) Systematic educational efforts should be made to teach or develop updated agricultural literacy in students of any age; 2) Teaching science through agriculture would incorporate more agriculture into curricula, while more effectively teaching science; 3) the quality of vocational agriculture programs must be enhanced by programmatic leadership, agricultural science, agribusinesses, marketing, management and food production and processing.

In summary, it is easy to discover that the need for education related to biomass production is linked to the missions of agricultural education: career development, science education as well as leadership development.

Teacher Education for Agricultural Education

The National Council for Agricultural Education (2000) gave a series of recommendations on reinventing agricultural education for the future: 1) Ensure there are abundant highly motivated, well-educated teachers providing agriculture, food, fiber and natural resources systems education. 2) Provide all students with access to seamless, lifelong instruction in agriculture, food, fiber and natural resource systems in diverse educational settings. 3) Make sure all students are conversationally literate in agriculture, food, fiber and natural resource systems. 4) Ensure a continuous education about agriculture, food, fiber and natural resources systems. To achieve those goals by 2020, a high-quality teacher training system has to be provided to the current agriculture teachers and future agriculture teachers.

Phipps, Osborne, Dyer, & Ball (2008) also provided an interpretation on agricultural teacher education:

> Agriculture teacher education encompasses many dimensions, including program planning and evaluation, curriculum and course development, instructional design, teaching methods, teaching and learning processes, learning assessment, laboratory and facility design and use, instructional technology, adult and youth development, experiential learning, and many other areas. Agricultural educators use their expertise in these core areas to prepare youth and adults for entry and advancement in the agricultural industry and to create a better understanding of how our industry can provide such an abundant supply of food, fiber, and other products for consumers (p. xxvii).

The textbook of *Foundations of Agricultural Education* by Talbert, Vaughn, Croom, Lee (2007) indicated how agricultural educators become successful in their education career:

> Agricultural education in the local school community will be only as successful as the skills and abilities of the agriculture teacher will allow. The teacher is essential to the success or failure of the program and must be highly qualified, well trained, and enthusiastic about the profession of teaching. Teachers must not only master the art and practice of teaching, but they must also stay current in the technical content of the profession. Teachers must have professional development plans that allow them to stay abreast of recent developments in the field of agriculture. Even the best teachers become ineffective when the technical content of their lessons become outdated (p. 57).

Talbert, Vaughn, Croom, Lee (2007) also gave some recommendations regading the curriculum in agricultural education:

> The agricultural education curriculum should be driven by the market demand in agricultural occupations. The instructional program should provide learning experiences that prepare students for the entry point into agricultural jobs in the community, even if the skills needed by the agricultural industry in that local economy are less efficient and less technical than in other communities. For instance, if the local economy needs workers to operate farm machinery, the instruction should prepare students for jobs of that type (p. 57).

Curriculum Development

The Food and Agriculture Organization of the United Nations (FAO) released a curriculum development model for teaching agricultural subjects created by Sawi (1996).

> The curriculum development process systematically organizes what will be taught, who will be taught, and how it will be taught. Each component affects and interacts with other components. For example, what will be taught is affected by who is being taught (e.g., their stage of development in age, maturity, and education). Methods of how content is taught are affected by who is being taught, their characteristics, and the setting (p. 3).

The curriculum development model (*Figure 1*) shows how these components relate to each other and to the curriculum development process:

> It begins when an issue, concern, or problem that needs to be addressed. If education or training a segment of the population will help solve the problem, then the curriculum to support an educational effort becomes a priority with human and financial resources allocated. The next step is to form a curriculum development team. The team makes systematic decisions about the target audience (learner characteristics), intended outcomes (objectives), content, methods, and evaluation strategies. With input from the curriculum development team, draft curriculum products are developed, tested, evaluated, and redesigned -if necessary. When the final product is produced, volunteer training is conducted. The model shows a circular process where volunteer training provides feedback for new materials or revisions to the existing curriculum (Sawi, 1996. p. 3).

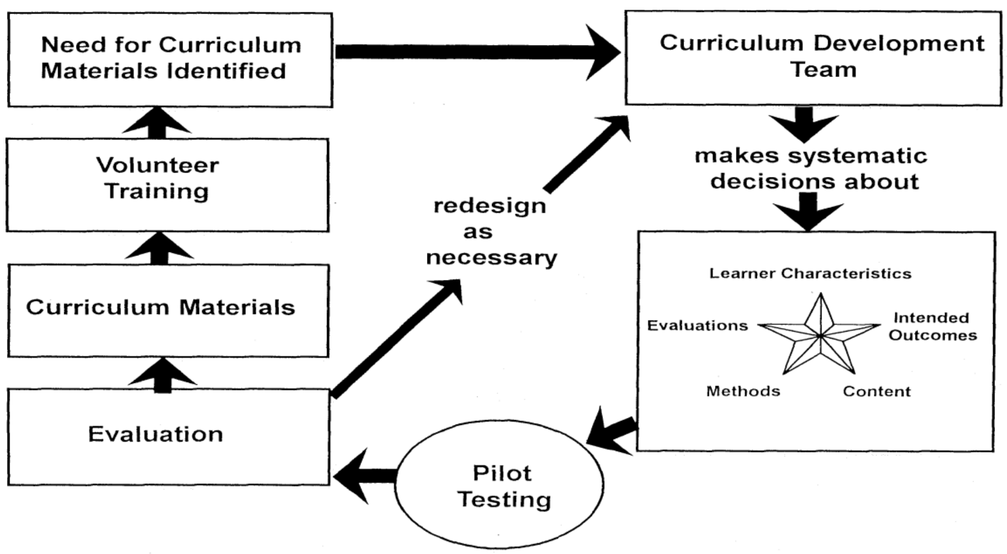

Figure 1. The Food and Agriculture Organization of the United Nations curriculum development mode. Adapted from "Curriculum Development Guide" by Sawi, G. E. (1996). Retrieved from: http://www.fao.org/docrep/009/ah650e/AH650E00.htm

In addition to the overall model, Sawi (1995) gave a set of systematic action plans to facilitate teachers to develop the curriculum: Phase I is planning which includes identifying the issue, problem and need, form curriculum development team, and conduct needs assessment and analysis. Phase II is content and methods which includes state intended outcomes, select content and design experiential methods. Phase III is implementation which includes producing the curriculum product, test and revise curriculum, recruit and train facilitators, and implement the curriculum. Phase IV is evaluation and reporting which includes designing evaluation strategies and reporting and securing resources.

From Sawi's (1995) curriculum development model and the action plan, the cornerstone of the whole model is to identify the issue, problem and need. Thus knowing teachers' perceptions regarding the issue and/or problem, and assessing the teachers' needs provided the foundation for curriculum development.

Teachers' Perceptions and Beliefs

Van Den Ban and Hawkins (1996) defined perceptions is a "process by which we receive information or stimuli from our environment and transform it into physiological awareness" (p. 282). According to the study by Van Den Ban and Hawkins (1996), facing a great amount of stimuli from the environment and information, an individual pays attention only to a selection of the stimuli (Van Den Ban & Hawkins, 1996). The selection is influenced by many physical and psychological factors (Van Den Ban & Hawkins, 1996). In addition, the perception is organized in the ways that make sense to the individual (Van Den Ban & Hawkins, 1996).

Without understanding the teachers' perceptions and beliefs about teaching a subject, it is hard to provide teachers with corresponding support to improve teaching and learning (Susuwele-Banda, 2005). "…Within any 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).

"Teachers' beliefs have a powerful impact on their willingness to adopt new teaching strategies" (Tarman, 2012, p. 1965). Tobin, Tippins, and Gallard (1994) encouraged future researchers to enhance the understanding of teachers' beliefs and perceptions prior to making educational policies. Tarman (2012) indicated that in recent years, teachers' beliefs had been the subject of inquiry to clarify how beliefs are improved and how they affect the teachers' practices. Examining teachers' beliefs and perceptions could provide both a new focus and potential for teacher education programs that do not now exist.

Theory of Reasoned Action

The Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980) is a model (*Figure 2*) that helps people study perceptions and understand the relationships between perceptions and behaviors. According to the TRA (Ajzen & Fishbein, 1980), people's behaviors are determined by one's attitude towards the outcomes of behavior and opinions of the environment. Ajzen and Fishbein (1980) thought intentions predict individual behaviors and intention is an individual's plans to either perform or not to perform a particular behavior. Furthermore, some previous researchers believe that it is imperative to explain and define beliefs and attitudes in the model. 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. "According to Fishbein and Ajzen (1975), in general, an individual will hold a positive attitude toward a given behavior if an individual believes that the performance of the behavior will lead to mostly positive outcomes" (Lawver, 2009, p. 7). Understanding a person's behavior requires more than just knowledge of his/her intention; it is more appropriate to measure their intention in order to predict their behavior (Fishbein & Ajzen, 1975).

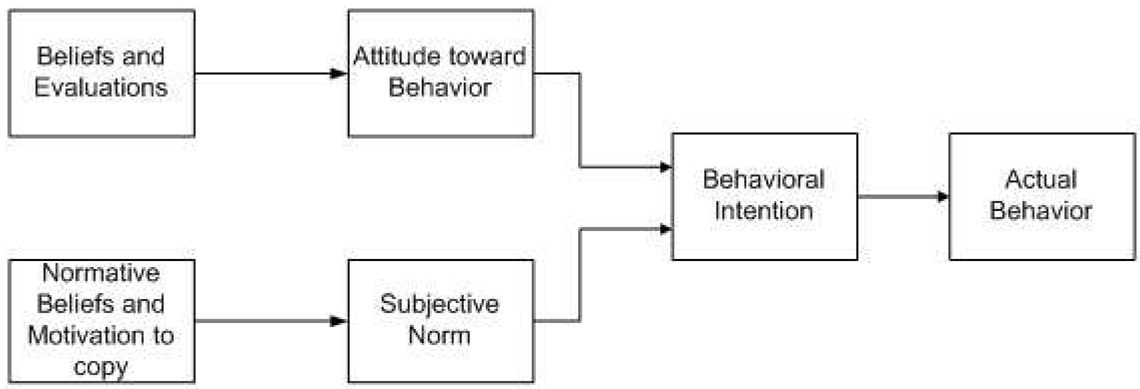

Figure 2. Theory of Reasoned Action. Adapted from "Understanding Attitudes and Predicting Social Behavior" by Ajzen, I. and Fishbein, M, 1980, Englewood Cliffs, NJ: Prentice-Hall.

Many previous relevant studies were conducted by using the TRA as framework. Muma (2006) found that the choice of teaching methods by agriculture teachers is partly dependent on the extent to which sustainable agriculture is taught. LaVergne, Jones, Larke Jr and Elbert (2012) revealed that there were statistically significant differences in teachers' perceptions toward the benefits of diversity inclusion. In the dissertation research study conducted by Lawver (2009), TRA served as the theoretical framework to analyze the factors that influenced agriculture teachers' choice to teach. This current research study utilized the TRA model to predict teacher behaviors regarding teaching about biomass based on teachers' perceptions, and analyzing factors that may affect the teachers' perceptions.

Several recent studies selected the Theory of Planned Behavior (TPB) as the theoretical framework (Myers & Washburn, 2008; Beckman & Smith, 2008; Lamm,

Lamm, & Strickland, 2013). In fact TPB is a derivative of TRA. TRA has been criticized for neglecting the importance of social factors that in real life could be a determinant for individual behaviour (Grandon & Peter P. Mykytyn 2004; Werner 2004). Ajzen (1991) proposed an additional factor in determining individual behavior in TPB , which is perceived behavioural control. Perceived behavioural control is an individual perception on how easily a specific behavior will be performed (Ajzen 1991). However, TPB contains the same core principles of TRA. Given that no behavioural control is involved in this research. It is appropriate to use TRA to ground this research.

In-service Teacher Education Programs

The educational needs for any one community do not remain constant (Gordon, 1958). Today, a rapidly changing time with constant progress of science and technologies, teachers' teaching competences have to keep improved and update (Tennessee Department of Education, n.d.) To achieve this goal, teachers need to gain more training through in-service education programs (Gordon, 1958).

Mincemoyer and Kelsey (1999)'s study explained what in-service education is:

> In-service education has been defined as education delivered in a structured setting that enables one to become more competent professionally, that is, to further develop technical subject matter competencies to keep abreast of and, if possible, ahead of change, and to explore educational and technological content and processes in varying depth and to extend personal competencies (p. 1).

Leu and Ginsburg (2011) stated what benefits teachers can get from participating in-service education programs:

> In-service programs help teachers acquire or deepen their knowledge about the subject matter content, teaching skills, and assessment methods

> required to implement an existing or a new curriculum as well as assist them in working effectively with parents and other community members (para.1).

To develop effective in-service teacher education programs, as the suggestions of Leu and Ginsburg (2011), ten key principles should be followed:

1. Consider in-service programs as part of a continuum of professional development.
2. Involve teachers in planning programs.
3. Emphasize pedagogical content knowledge in designing program content.
4. Use adult-oriented models of active learning as the pedagogical design for in-service programs.
5. Build reflective practice within teacher learning communities.
6. Include all teachers in learning opportunities and base most of the in-service program at the school or school-cluster level.
7. Incorporate strong instructional leadership by school administrators and local supervisors.
8. Link teacher in-service to a more holistic school improvement approach involving community members in planning for and monitoring of school quality.
9. Successful participation in in-service professional development programs should receive official recognition by the ministry or local authority. This, coupled with demonstrated improved classroom practice, should lead to increased financial rewards and/or advancement on a structured career ladder.
10. Consider budget implications of building realistic and sustainable programs (p. 2-5).

Needs Assessment

According to the FAO's curriculum development model (Sawi, 1996), needs assessment is the pre-requisite for building the contents of a curriculum. In addition, Leu and Ginsburg's (2011) second principle of developing effective in-service education program also require to collect the information regarding teachers' needs.

McCawley (2009) defined needs assessment as "…a systematic approach to studying the state of knowledge, ability, interest, or attitude of a defined audience or group involving a particular subject" (p. 3).

Furthermore, the McCawley (2009) explained why educational researchers or teacher educators need to conduct needs assessment.

> A needs assessment is conducted so the target audience can verify its own level of knowledge and skill, its interests and opinions, or its learning habits and preferences. Collecting and analyzing needs assessment data allows the investigator to describe the gap between what exists and what is needed. Filling that gap becomes the purpose of the next generation of educational services and products (p. 3).

In the field of agricultural education, Borich (1980)'s needs assessment model has been widely used as theoretical framework in conducting research on teachers' needs assessment by teacher educators and educational researchers (Garton & Chung, 1996; Saucier & McKim, 2011; McKim & Saucier, 2011). Zarafshani & Baygi (2008)'s research provided an insight review on Borich (1980)'s needs assessment model:

> Borich (1980) defined a training need as 'a discrepancy between an educational goal and trainee performance in relation to this goal.' He further suggested that training programs could utilize his model by employing the two extreme positions: what is (the measured behaviors, skills, and competencies of trainees) and what should be (the goals of the training program). Note the concept of competency implied by the needs assessment model: Competencies are the application of knowledge, technical skills, and personal characteristics leading to outstanding performance (p. 349).

> According to Borich (1980), the discrepancy between these two positions can be used as an index to determine the effectiveness of training. The

> Borich Needs Assessment Model involves four steps: (1) list competencies; (2) survey in-service teachers; (3) rank competencies; and (4) compare high priority competencies with training program content (p. 349).
>
> The important practical characteristic of the Borich Need Assessment Model is that, it relies on faculties' judgments about their own performances. The assumption underlying the needs model is that the performers can best judge his or her own performance and, when explicitly asked to do so, can make an objective judgment. This can enhance the credibility of the self-report and provide an additional vantage point from which to judge discrepancies between program intents and faculties' performance. Moreover, it is a model that is easily implemented by university administrators with limited resources who need immediate feedback on the effectiveness of program experiences and materials (p. 350).

A Conceptual Framework from Perceptions Investigation to In-service Program Development

In the literature, many theoretical frameworks and conceptual frameworks provided instruction for conducting either perceptions investigation or a needs assessment study. However, no known framework existed in the literature that linked a perception investigation and a needs assessment study together with the focus on in-service programs development.

A conceptual framework, shows in *Figure 3,* is summarized from the existing theories and used to guide other studies. This framework fills the gap between teacher's perceptions and in-service program development. This framework integrates the Theory of Reasoned Action (Ajzen & Fishbein), Borich's (1980) needs assessment model and Gordon' s (1958) in-service teacher education program development principles.

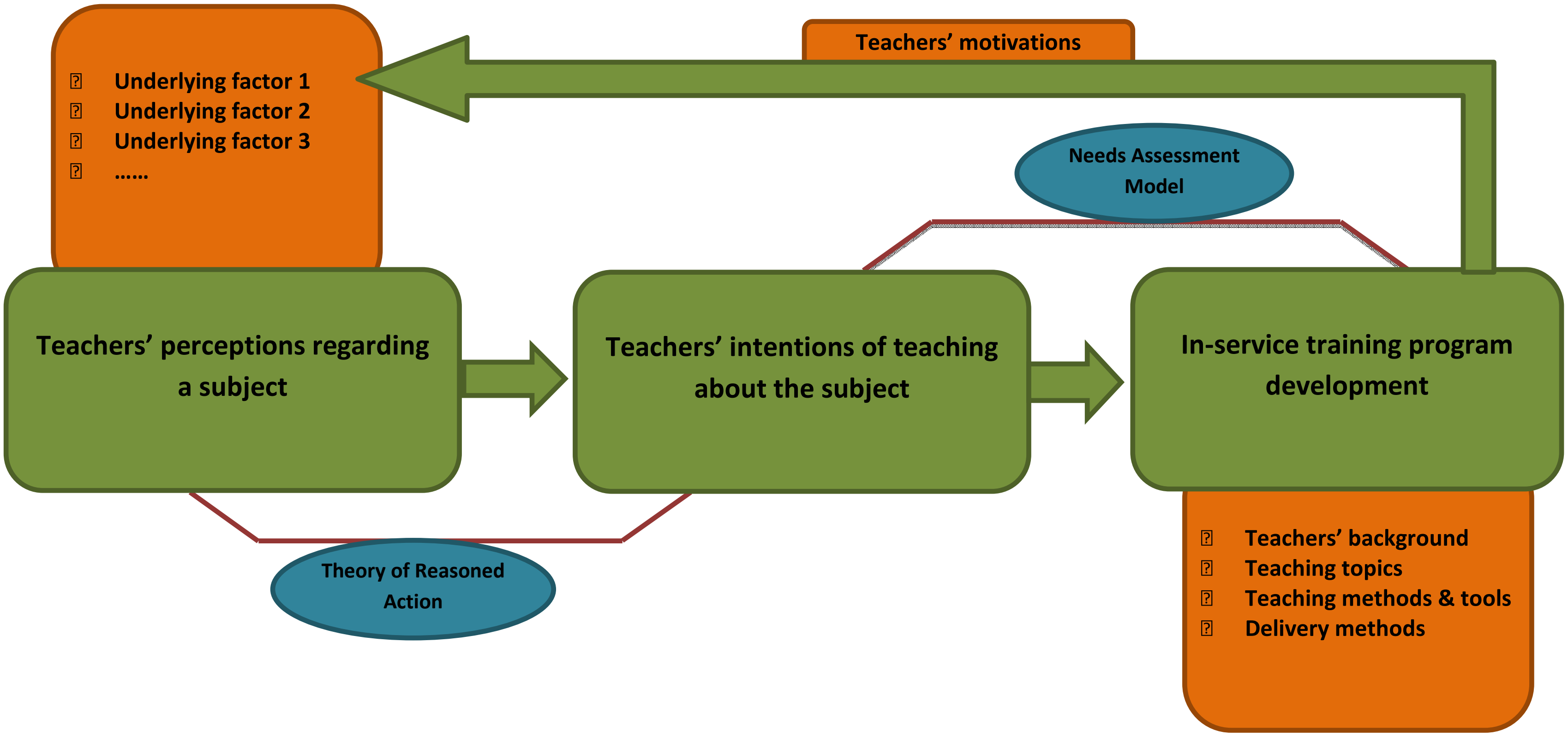

Figure 3. A general framework from an investigation of perceptions to development of in-service programs

Summary

Through this chapter, researchers identified the existing issues of biomass production in agriculture, found the significance of conducting a study on teachers' perceptions regarding biomass production education, and disclosed educational needs for biomass production. In addition, researchers paved a solid theoretical foundation to instruct this study by referring the TRA, Borich's (1980) Needs Assessment Model, Leu and Ginsburg's (2011) ten key principles of developing in-service education programs, as well as Sawi's (1996) curriculum development model. Next chapter focuses on demonstrating how the researchers designed, implemented, tested, and analyzed this study.

CHAPTER III. METHODS AND PROCEDURES

This chapter is divided into eight sections as follows: research objectives, research design, instrumentation, Population and sampling, data collection, statistical analysis of the data, limitations of the study, assumptions for the study, and summary.

Purpose and Objectives of the Study

The overall purpose of this study was to determine the perceptions held by agriculture teachers of secondary schools in Iowa regarding biomass production education. The following specific objectives were developed in order to provide a framework for conducting this study:

1. To describe the perceptions of agriculture teachers regarding biomass production.
2. To describe the perceptions of agriculture teachers regarding teaching about biomass production.
3. To identify the biomass production topics needed by agriculture teachers through in-service training.
4. To identify the teaching methods and tools frequently used by agriculture teachers.
5. To determine the relationship between the overall perceptions regarding biomass production and the overall perceptions regarding teaching about biomass production.
6. To determine if a model exists predicting the overall perceptions regarding teaching about biomass production, from demographic information: (a) gender;

(b) age; (c) years of teaching experience; (d) the highest degree; (e) levels taught; (f) subjects endorsed to teach in addition to agriculture; (g) membership of a selected professional organization; (h) attending any past workshops about biomass or bioenergy.

7. To identify factors underlying agriculture teachers' perceptions toward biomass production education.
8. To determine the proportion of variance in the teachers' perceptions that can be explained by these factors.

Research Design

This study adopted a descriptive-correlational research design method to assess agriculture teachers' perceptions regarding a new technology and potential teaching topic.

Literature has shown this type of research design is justified because the objectives of the study sought to describe teachers' beliefs, perceptions, topics and methods of teaching a subject (Ary, Jacobs, & Razavieh, 2002; Lawver, 2009; Muma, 2006). Questionnaires have been used to gather information from the target population in this descriptive-correlational research (Dillman, 2007). After the questionnaire was developed, prior to data collection phase, the researchers submitted all the related materials to the Institutional Review Board (IRB) of Iowa State University, and received approval (see Appendix A) from the IRB with IRB number: 13-280.

Instrumentation

The research instrument was a survey questionnaire (see Appendix B) developed and formatted to suit the purpose of this study after carefully reviewing similar studies by Feng (2012), Kwaw-Mensah (2008) and Sikinyi (2003). Items in each part were based on the literature review on biomass production and agricultural education. The survey instrument in this study consisted of six sections:

Part I served to measure 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 each statement on a five-point Likert-type scale: SD= Strongly Disagree; D= Disagree; N= Neutral; A= Agree; SA= Strongly Agree.

Part II was designed to describe the perceptions of agriculture teachers toward teaching about biomass production. Eight statements, including one reversed statement was given to assess the extent of positive or negative perceptions regarding teaching about biomass production. Participants were asked to indicate the level of agreement with each statement on a five-point Likert type scale: SD= Strongly Disagree; D= Disagree; N= Neutral; A= Agree; SA= Strongly Agree.

Part III was utilized to identify the topics in teaching about biomass production needed by the agriculture teachers that would require future in-service training. Thirteen topics related to biomass production were listed in this section. Two sets of Likert-type scales were used to let participants indicate both the level of importance and the degree of training needed for each topic. The Key for level of importance was: 1= Very unimportant; 2= Unimportant; 3= Neutral; 4= Important; 5= Very important. The key for degree of need: 1= No need at all; 2= Slight need; 3= Moderate need; 4= High need. In addition to the thirteen topics, blank areas were available for additional topics proposed by the participants.

Part IV was designed to identify the teaching methods or teaching tools that have been frequently used by teachers. Eighteen teaching methods and tools were listed along a set of three-point Likert-type scales: 1= Do not use; 2 = Occasionally use; 3 = Often use. Open space was provided for any additional teaching methods or tools.

Part V was employed to gather demographic information of participants. Ten multiple choice questions and text-entry questions were asked about the participants' demographics including gender, age, years of teaching experience, 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 carefully reviewed and revised the survey instrument. Five members of the panel were from the Department of Agricultural Education and Studies at Iowa State University, who are the experts in conducting educational research. The other four members are from the Department of Agronomy at Iowa State University representing the professionals related to biomass production research.

A pilot study was conducted with a small group of secondary school 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. Section three and section four of the survey had no consistent variables within each section, thus the reliability coefficient is not necessary. Equivalent-forms reliability was established by the volunteers in the pilot-study (Ary, Jacobs & Sorensen, 2010).

Population and Sampling

The target research population included all of the current secondary school agriculture teachers in Iowa. According to Iowa Agriculture Teachers Directory, there are two hundred and forty seven (N= 247) agriculture teachers serving in Iowa’s secondary schools at the time of the study in 2013. Because of the limited size of the target population, a sampling procedure was not involved in the study. Instead, all agriculture teachers were given a survey instrument.

Data Collection

Israel (2013) indicated a mixed-mode of survey distribution can increase the response rate. A hard-copy and an electronic-copy of the questionnaires were distributed to all secondary school agriculture teachers in Iowa. Hard-copy questionnaires (see Appendix B) were distributed at the 2013 conference of Iowa Association of Agricultural

Educators in Ankeny, Iowa. Electronic-copy questionnaires (see Appendix C) were built by Qualtrics, and sent out to all the teachers' email addresses according to the directory. There were three reminders.

A cover letter (see Appendix D) was attached on the top of the questionnaire. The cover letter stated the purpose of this survey, the confidentiality or anonymity of participants, instruction of participation, and a description of the topic of the survey and the content of the questions on the survey. Contac information of the researcher was shown on the cover letter for participants' questions or concerns.

In this study, after processing the data, a total of 100 (n=100) valid respondents returned questionnaires to the researchers for 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 result in significant differences between early and late respondents, thus affecting the external validity of the study (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 "students want to learn about biomass production", and the level of agreement with "biomass production contributes to the local economy" were accounted for by comparing early and late respondents with an independent samples t-test. Table 1 presents the results. No statistically significant difference was found at .05 level. The non-response bias was not a significant threat to generalize the conclusions from this study.

Table 1

Comparison of Early and Late Respondents on Selected Variables

Variable	Early Respondents			Late Respondents			*p*
	n	*Mean*	*SD*	*n*	*Mean*	*SD*	
Age	25	33.12	11.77	22	41.00	12.70	.59
Student learn biomass	25	3.16	.62	26	3.00	.89	.38
Local economy	25	4.08	.57	26	4.04	.66	.59

Statistical Analysis of the Data

Descriptive statistics

Descriptive statistics were used to address research objective one, research objective two and research objective four. Means, Standard Deviations, and Frequencies were calculated to describe the perceptions of agriculture teachers toward biomass production (questionnaire Part I), describe the perceptions of agriculture teachers toward teaching about biomass production (questionnaire Part II) and identify the teaching methods and tools agriculture teachers like to use in teaching agriculture (questionnaire Part IV). All descriptive statistics were calculated and shown in SPSS.

Mean Weighted Discrepancy Score

The Mean Weighted Discrepancy Score (MWDS) has been widely used to identify where educators' in-service or training needs exist (Borich, 1980; McKim & Saucier, 2011). MWDS was calculated to achieve research objective three: To identify the important topics of teaching about biomass production needed by agriculture teachers and covered by in-service training. The calculation of MWDS followed the description of the study of Garton and Chung (1997):

> A *discrepancy score* for each individual on each professional competency was calculated by taking the importance rating minus the ability (competence) rating. A *weighted discrepancy score* was then calculated for each individual on each of the professional competencies by multiplying the discrepancy score by the mean importance rating. A *mean weighted discrepancy score* for each of the professional competencies was calculated by taking the sum of the weighted discrepancy scores and dividing by the number of observations (p. 53).

The importance rating was from the first Likert-type scale in the questionnaire section III, and the ability rating was from the reversed coded data from the second Likert-type scale in the questionnaire. All data were also re-coded into a five –point Likert-type scale to match the formula of Garton and Chung (1997).

Pearson Product-Moment correlation coefficient

A Pearson Product-Moment correlation coefficient (Pearson's *r*) was calculated for objective five: To determine the relationship between the overall perceptions regarding biomass production and the overall perceptions regarding teaching about biomass production. Pearson's *r* is a measure of the linear correlation between two variables, giving a value between +1 and −1 inclusive, where 1 is total positive correlation, 0 is no correlation, and −1 is total negative correlation. It is widely used in the sciences as a measure of the degree of linear dependence between two variables (Galton, 1886; Wikipedia, 2014).

Multiple regression analysis

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

In order to accomplish the objective the researchers used multiple regression analysis. In conducting the multiple regression analysis, the dependent variable was each respondent's overall perceptions regarding biomass. The independent variables included age, years of teaching experience 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). 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).

Exploratory factor analysis

To achieve research objectives seven and eight, twenty statements about the teachers' perceptions toward biomass production education on a five-point Likert-type scale from questionnaire Part I and Part II were selected and analyzed by exploratory factor analysis (EFA). A data set from 100 copies of the completed questionnaire provided an adequate number of observations for factor analysis as suggested by Hair et al. (1995). As suggested by Miller and Shih (1999), procedures for conducting the factor analysis were patterned after those used by McCaslin and Torres (1992). Maximum Likelihood, namely common factor analysis, was adopted in this study since it has been commonly used in EFA by researchers in agricultural education (Miller & Shih, 1999). Common factor analysis is more appropriate when measured variables are assumed to be a linear function of a set of unmeasured or latent variables (Ford, MacCallum, & Tait, 1986). Oblique rotation was selected to acquire more accurate results for research involving human behaviors (Costello & Osborne, 2005). Both Direct Oblimin and Promax methods of rotation were conducted to find the more appropriate rotated factor pattern (Field, 2009). To test the suitability of conducting factor analysis, Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) test and Bartlett's test of Sphericity were conducted. The first EFA was conducted to determine the number of factors, and further EFA(s) was/ were conducted to find an appropriate factors' loading pattern.

Assumptions of the Study

The following assumptions were made regarding the study:

1. The instrument and scales constructed for the measurement of the variables related to the teachers' perceptions were valid, reliable and appropriate for the purpose of this research. This assumption was verified by the pilot study.
2. All the agriculture teachers read and understood the questions on the questionnaires in the same way with the researchers.
3. All the respondents answered the questions on the questionnaires after careful reading the instructions and questions.
4. All the agriculture teachers owned a basic knowledge base and common sense about biomass and bio-energy.
5. This study focused on the general concept of biomass rather than the specific varieties of biomass.

Limitations/Delimitations

1. This study was limited to the secondary school's agriculture teachers in Iowa.
2. The study investigated the teachers' perceptions regarding biomass production education. However, the perceptions may be varied along time's change.
3. This census designed study got 40.5% response rate. Though the non-response error was expelled by the comparison between early response and late response, the low response rate was a potential threaten for the generalization of the conclusions from this study.

4. This study was designed to assess the teachers' perceptions as a group. Individuals' perceptions were not the focus of this study.

Summary

The purpose of this study was to determine the perceptions of agriculture teachers of secondary schools in Iowa regarding biomass production education. IRB approval was acquired before any data collection in this study. A survey instrument was well developed to collect data by a panel of experts and a pilot study was used to build validity and reliability. The survey instrument was distributed to the target research population: high school agriculture teachers in Iowa. Data from 100 completed questionnaires were analyzed in SPSS. Descriptive statistics, Mean Weighted Discrepancy Score, Pearson Product-Moment correlation coefficient, and Exploratory factor analysis were utilized to address the eight research objectives. This chapter has provided an overview of the research methods and data collecting and analyzing procedures used in this study. Chapter IV will present the corresponding results.

CHAPTER IV. FINDINGS

The purpose of this study was to assess the perceptions of secondary school agriculture teachers in Iowa regarding biomass production education and the teachers' in-service needs regarding biomass production education. To accomplish this purpose, eight research objectives were established:

1. To describe the perceptions of agriculture teachers regarding biomass production.
2. To describe the perceptions of agriculture teachers regarding teaching about biomass production.
3. To identify the biomass production topics needed by agriculture teachers through in-service training.
4. To identify the teaching methods and tools frequently used by agriculture teachers.
5. To determine the relationship between the overall perceptions regarding biomass production and the overall perceptions regarding teaching about biomass production.
6. To determine if a model exists predicting the overall perceptions regarding teaching about biomass production, from demographic information: (a) gender; (b) age; (c) years of teaching experience; (d) the highest degree; (e) levels taught; (f) subjects endorsed to teach in addition to agriculture; (g) membership of a selected professional organization; (h) attending any past workshops about biomass or bioenergy.

7. To identify factors underlying agriculture teachers' perceptions toward biomass production education.
8. To determine the proportion of variance in the teachers' perceptions that can be explained by these factors.

To achieve all the research objectives, data were collected through a research survey questionnaire and analyzed by the statistical analysis software, SPSS. Chapter IV presents the findings of the study. Following the purpose and research objectives, results of the statistical analysis procedures used to address the objectives of the study are described.

Demographics of Respondents

Of the 100 high school agriculture teachers in the study who returned for the survey questionnaire, 32 (32%) were female and 68 (68%) were male. *Figure 4* presents the data.

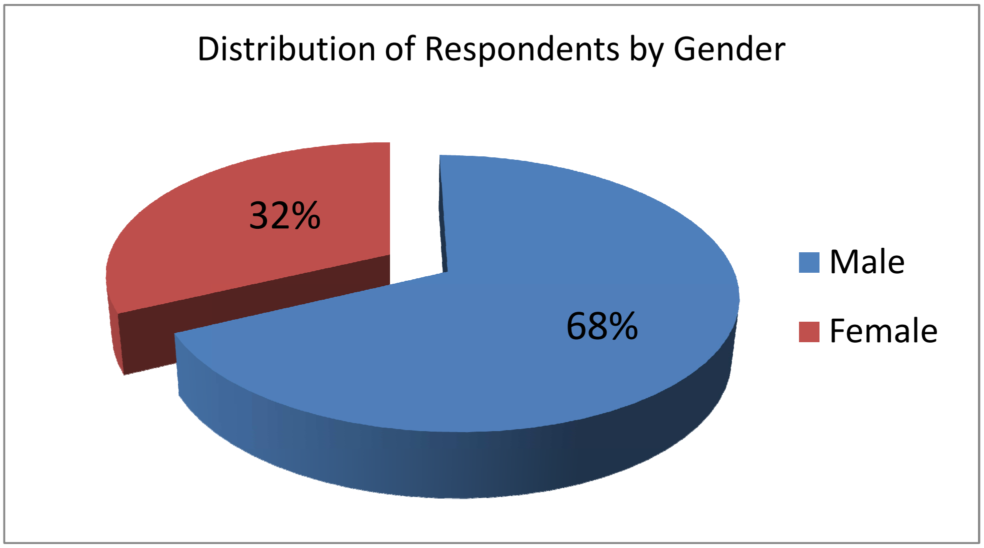

Figure 4. Distribution of respondents by gender

The age distribution of the agriculture teachers in this study is presented in Table 2. The mean age of the agriculture teachers was 39.2. The majority (60.5%) of the agriculture teachers were in the age range of 31 to 60. Teachers with an age less than 30 represented a significant proportion (36.5%) of the target group. Only 3% of the teachers were older than 60.

Table 2

Age Distribution of the Agriculture Teachers

Variable	Categories	*f*	Percent (%)
Age	21-30	35	36.5%
	31-50	34	35.5%
	51-60	24	25.0%
	>60	3	3.0%

Note. n = 96.

The years of teaching experience of the agriculture teachers are shown in Table 3. The average years of teaching were 14.6 years. Over one third (35.8%) of the teachers are new teachers, with teaching years of experience less than 5 years. In this study, 11.6% of the teachers' years of teaching experience ranged from 5 to 10 years. Another one third (32.6%) of the teachers had been teaching from 11 years to 30 years. In addition, 3.7 % of the teachers had more than 30 years of teaching experience.

Table 3

Teaching Experience Distribution of the Agriculture Teachers

Variable	Categories	*f*	Percent (%)
	<5	34	35.8%
	5-10	11	11.6%
Teaching experience (years)	11-20	19	20.0%
	21-30	18	18.9%
	>30	13	13.7%

Note. n = 95.

As shown in the Table 4, 100% of the respondents taught in high school, grades 9-12, which is matched with the research population. In addition to teaching in high school, 2.1% of the teachers also taught in middle school, grades 6-8.

Table 4

Teaching Grades Distribution of the Agriculture Teachers

Variable	Categories	*f*	Percent (%)
Teaching grades	6-8	2	2.1%
	9-12	95	100%

Note. *n* = 97.

State licensed subject endorsements are listed in the Table 5. All of the teachers (100%) were endorsed for teaching agriculture. Nearly half of the teachers (47%) were endorsed to teach biology in addition to teaching agriculture, and 27% of the teachers were endorsed to teach science.

Table 5

State Licensed Subject Endorsements of the Agriculture Teachers

Variable	Categories	*f*	Percent (%)
	Agriculture	100	100%
	Biology	47	47%
	Science	27	27%
	Chemistry	2	2 %
Subject Endorsements	Physics	1	1%
	Industrial Art	4	5%
	Family Consumer Science	1	1%
	Math	1	1%
	P.E.	1	1%

Note. n = 100.

Table 6 reflects the teachers' educational background, a majority of the agriculture teachers (70.8%) held a Bachelor's degree as their highest education level, and 29.2% of the teachers' highest education level were Master's degree.

Table 6

Educational Background of the Agriculture Teachers

Variable	Categories	*f*	Percent (%)
Highest degree	Bachelor	68	70.8%
	Master	28	29.2%

Note. n = 96.

As shown in Table 7, a majority of the agriculture teachers (63%) were a member of Iowa Association of Agricultural Educators, and 34% of the teachers held a membership in National Association of Agricultural Educators. In addition to the affiliations in the field of Agricultural Education, a small proportion of the teachers (9%) were involved in Iowa Association for Career and Technical Education or the Association for Career and Technical Education. Nevertheless, nearly one third of the teachers (33%) had no professional affiliation.

Table 7

Professional Affiliations of the Agriculture Teachers

Variable	Categories	*f*	Percent (%)
	IAAE	63	63%
Professional affiliations	NAAE	34	34%
	IACTE	7	7%
	ACTE	2	2%
	MAAE	1	1%
	None	33	33%

Note: *Note. n* = 100. IAAE = Iowa Association of Agricultural Educators. NAAE = National Association of Agricultural Educators. IACTE = Iowa Association for Career and Technical Education. ACTE = the Association for Career and Technical Education. Each teacher can involve in more than one organization.

Objective 1: The Perceptions of Agriculture Teachers Regarding Biomass Production

The first objective of this study was to describe the perceptions of Iowa agriculture teachers regarding biomass production. The *frequency distributions*, *means*, and *standard deviations* of each statement on the perceptions regarding biomass production statements are shown in Table 8. The *mean* ratings 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%, n = 92) agreed to strongly agreed “using biomass for fuel can improve energy security”. In addition, a majority of the respondents (86%, n = 86) agreed to strongly agree with “biomass production contributes to the local economy”, and 85% (n = 85) of the respondents agreed to strongly agree with “biomass production contributes to the local job market”. On the other hand, slightly less than half of the respondents (49%, n = 49) agreed to strongly agreed with “the principles of biomass production are easy to understand”. Nearly half of the respondents (48%, n = 48) held neutral perceptions on the statement “the technology of biomass production is easy to practice” (M = 3.04, SD = .80).

Table 8

Frequency Distributions, 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 2: The Perceptions of Agriculture Teachers Regarding Teaching about Biomass Production

The second objective of this study was to describe the perceptions of agriculture teachers regarding teaching about biomass production. The *frequency distributions, means,* and *standard deviations* of each statement are shown in the Table 9. The means ranged from 3.06 to 4.01, which indicated, in general, teachers had moderately positive perceptions towards teaching about biomass production.

A majority of the respondents (80%, *n* = 80) agreed to strongly agreed with "teaching about biomass production is relevant to science education". In addition, 85% (*n* = 85) of the teachers thought more training would be needed before teaching about biomass production. More than half of the teachers (64%, *n* = 64) agreed to strongly agreed that "teaching about biomass production will help students with their careers". In addition, 52% (*n* = 52) of the teachers agreed to strongly agreed 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 about biomass production. A large proportion of the teachers (60%, *n* = 60) were neutral on “students want to learn about biomass production”.

Table 9

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

Perception statement regarding teaching about biomass production	*f*						
	SD	D	N	A	SA	*M*	*SD*
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 no 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 3: The Important Topics Regarding Teaching about Biomass Production Needed by Agriculture Teachers through In-service Training

The third objective of this study was to identify the important topics related to teaching about biomass production needed by Iowa agriculture teachers through in-service training. The topics related to teaching about biomass production were ranked by the Mean Weighted Discrepancy Score (MWDS) of each topic, and are shown in Table 10. All the topics were rated as very important to somewhat important. However, the level of competent to teach the topics was not strong.

Seven topics were identified in great need for future in-service training. The top seven topics' MWDS were greater than 6.00. The top seven topics included harvesting of biomass for sustainability (7.44), selection of plant species for biomass production (6.75), soil modification for biomass production (6.55), farming systems including biomass, food crop, and livestock production (6.36), basic procedures used to convert biomass to biofuel (6.32), carbon cycle in biomass production (6.29), and harvesting of biomass for profit (6.19). The topic "the history of bioenergy and the related biomass" received a MWDS less than 3.00 indicating less of a need for in-service education.

Table 10

Rating of Selected Topics Related to Teaching about Biomass Production and Mean Weighted Discrepancy Score

Ranking	Topics	Imp. level [a]	Comp. level [b]	MWDS[c]
1	Harvesting of biomass for sustainability	4.02	2.17	7.44
2	Selection of plant species for biomass production	3.90	2.23	6.75
3	Soil modification for biomass production	3.82	2.10	6.55
4	Farming systems including biomass, food crop, and livestock production	3.85	2.20	6.36
5	Basic procedures used to convert biomass to biofuel	3.80	2.13	6.32
6	Carbon cycle in biomass production	3.82	2.19	6.29
7	Harvesting of biomass for profit	3.85	2.24	6.19
8	Biological material for biomass	3.79	2.23	5.94
9	Marketing information about biomass	3.76	2.27	5.60
10	Biomass feedstock	3.70	2.42	4.73
11	The use of biomass feedstock	3.68	2.42	4.61
12	Policy issues related to biomass	3.50	2.30	4.20
13	The history of bioenergy and the related biomass	3.34	2.51	2.76

Note. n=88. [a] Importance Level: 5 = Very Important, 4 = Important, 3 = Somewhat Important, 2 = Of Little Importance, 1 = Not Important. [b] Competence Level: 5 = Very Competent, 4 = Competent, 3 = Somewhat Competent, 2 = Little Competence, 1 = Not Competent. [c] MWDS: Mean Weighted Discrepancy Score.

Objective 4: The Teaching Methods and Tools that frequently used by the Agriculture Teachers

The fourth objective of this study was to identify the teaching methods and tools frequently used by Iowa agriculture teachers. The *frequency distributions, means, and standard deviations* of each teaching method or tool are shown in the Table 11. In addition, Table 11 presents the ranking by *means* of the eighteen teaching methods or tools.

The most frequently used teaching method is discussion, and 97% (*n* = 93) of the teachers used it in teaching agriculture. In addition, the following teaching methods or teaching tools were very frequently (*M* > 2.0) used by the majority of agriculture teachers (Percentage ≥ 80%): demonstration (*M* = 2.46, *n* = 91, 95%); brainstorming (*M* = 2.27, *n* = 85, 88.5%); on-line videos (*M* = 2.27, n = 85, 88.5%); experiment (*M* = 2.25, n = 85, 88.5%); lab session (*M* = 2.22, *n* = 84, 87.5%); on-line articles (*M* = 2.21, *n* = 81, 84.4%); field trips (*M* = 2.13, *n* = 81, 84.4%);On-line data articles (*M* = 2.11, *n* = 77, 80.2%). Additionally, the other teaching methods or teaching tools including individualized instruction (*M* = 2.07, *n* = 77, 79.1%), lecturing (*M* = 2.05, *n* = 78, 81.2%), games and simulations (*M* = 2.04, *n* = 49, 51.0%), and resource people (*M* = 2.01, *n* = 78, 81.2%).

Table 11

Teaching Methods and Tools Used by the Agriculture Teachers

Ranking	Teaching methods and tools	*f*			*M*	*SD*
		1	2	3		
1	Discussion	3	37	56	2.55	.56
2	Demonstration	5	42	49	2.46	.59
3	Brainstorming	11	48	37	2.27	.66
4	On-line videos	11	48	37	2.27	.65
5	Experiment	12	48	36	2.25	.66
6	Lab session	12	51	33	2.22	.65
7	On-line articles	15	46	35	2.21	.69
8	Field trips	15	53	28	2.13	.65
9	On-line data	19	47	30	2.11	.71
10	Individualized instruction	20	49	27	2.07	.69
11	Lecturing	18	55	23	2.05	.65
12	Games and simulations	20	25	24	2.04	.68
13	Resource people	18	59	19	2.01	.62
14	Supervised study	28	47	21	1.92	.71
15	Case studies	29	47	20	1.91	.71
16	Debate	27	54	15	1.88	.65
17	Role play	32	55	9	1.76	.61
18	Webinar	70	21	5	1.32	.57

Note. *n* = 96. Original Scale: 1 = Do not use. 2 = Occasionally use. 3 = Often use.

***Objective 5*: The Relationship between the Overall Perceptions Regarding Biomass Production and the Overall Perceptions Regarding Teaching about Biomass Production**

The fifth 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 perceptions regarding biomass production (OPBP) was calculated from the arithmetic mean of every statement's score in section one of the questionnaire. The overall perceptions regarding teaching about biomass production (OPTBP) was calculated from the arithmetic mean of every statement's score in section two of the questionnaire. Appendix E shows the original data of OPBP as well as each OPTBP. In Table 12, the correlation matrix is displayed. The magnitude of relationships was determined 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 12

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

		OPBP	OPTBP
OPBP	*r*	1	.441*
	p		.000
	n	100	100
OPTBP	*r*	.441*	1
	p	.000	
	n	100	100

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

Objective 6: A Model to Predict the Overall Perceptions Regarding Teaching about Biomass Production

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

In order to accomplish the 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 (OPTBP) was calculated in *Objective 5* and shown in Appendix E. The independent variables included age, years of teaching experience 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 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). Two continuous variables are: 1) "*age*" and 2) "*years of being teaching*". 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 physics*", 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 workshops 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). Multicollinearity test found collinearity existed between the independent variable "age" (*VIF* = 11.1) and independent variable "years of being teaching" (*VIF* = 9.5). Delete the independent variable "age", and remain the independent variable "years of being teaching" as well as other nine independent variables.

Among the ten 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 13 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 13

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.

Objective 7 & 8: **Factors Underlying Agriculture Teachers' Perceptions toward Biomass Production Education & the Proportion of Variance in The Teachers' Perceptions Can be explained by These Factors**

Exploratory factor analysis (EFA) was conducted to achieve the seventh and eighth research objectives. Before conducting the analysis, a few assumptions were verified by process Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity (Field, 2009). Results of the tests are shown in Table 14. Sampling adequacy was well established with KMO measure = .596 > .5. The result of Bartlett's test (χ^2 (*df* = 105) = 580.39, *p* = .00) indicated the correlation matrix of all variables is not an identity matrix (Field, 2009) and it is applicable to conduct factor analysis. No violation of KMO and Bartlett's tests were found in all EFAs in this study.

Table 14

KMO and Bartlett's Test

Tests	Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	Bartlett's Test of Sphericity		
		χ^2	*df*	*p*
Results	.704	580.394	105	.000

Note. *n* = 100

In the first EFA, 6 factors with eigenvalues equal to or greater than 1.0 were retained. With the help of scree plot, 4 factors were finally taken into the consideration of further analyses. The second EFA provided factor loadings and factor pattern matrix with all statements. As the suggestion by Cabrera-Nguyen (2010), statements with factor loadings < .5 were suppressed, which resulted in that seven statements were dropped from the analysis. Another EFA were conducted on the thirteen statements with four factors with a good fit (χ^2 (*df* = 32) = 38.245, *p* = .207). The final factor pattern matrix and factor loadings are shown in Table 15. The four factors were labeled as: 1) Economic benefits; 2) Environmental considerations; 3) Students' learning confidence; 4) Student growth benefits.

Table 15

Rotated Factor Pattern Matrix Loadings for Teachers' Perceptions

Abbreviated Statement	Factor loadings			
	Factor 1[a]	Factor 2[b]	Factor 3[c]	Factor 4[d]
Local economy	.880			
Local job market	.876			
Farmers' income	.755			
Hurt soil		.779		
Hurt water		.970		
Threaten food security		.511		
Easiness of understanding			.569	
Easiness of practice			.531	
Easiness of course integration			.853	
Students' desire of learning			.651	
Science education benefit				.528
Career benefit				.988
Higher education benefit				.710

Note. n = 100. [a] Economic benefits; [b] Environmental considerations; [c] Students' learning confidence; [d] Student growth benefits.

The research objective eight was completed by Table 16. Each factor contributed 12% to 17% of the variance in the teachers' perceptions. Economic benefits contributed the biggest proportion (16.9%) of the variance in the agriculture teachers' perceptions regarding biomass production education; the second largest (14.8%) factor is environmental considerations; the following factors were students' learning confidence (14.5%) as well as student growth benefits (12.6%). Four factors accounted for approximately 58.8% of the variance in agriculture teachers' perceptions toward biomass production education.

Table 16

Percent of Variance Explained by Factors Influencing Teachers' Perceptions

Ranking	Factors	Percent of variance explained （%）	Cumulative percent （%）
1	Economic benefits	16.946	16.946
2	Environmental considerations	14.785	31.731
3	Students' learning confidence	14.532	46.263
4	Student growth benefits	12.568	58.831

Note. n = 100.

Summary

This chapter presented all the results and findings by descriptions, figures, and tables for the research objectives. Next chapter will focus on the discussions and interpretations of these results and findings presented in this chapter.

CHAPTER V. DISCUSSION OF THE RESULTES

The main purpose of this study was to assess the perceptions of secondary school agriculture teachers in Iowa regarding biomass production education and the teachers' in-service needs regarding biomass production education. Eight research objectives were developed to fully accomplish the main purpose:

1. To describe the perceptions of agriculture teachers regarding biomass production.
2. To describe the perceptions of agriculture teachers regarding teaching about biomass production.
3. To identify the biomass production topics needed by agriculture teachers through in-service training.
4. To identify the teaching methods and tools frequently used by agriculture teachers.
5. To determine the relationship between the overall perceptions regarding biomass production and the overall perceptions regarding teaching about biomass production.
6. To determine if a model exists predicting the overall perceptions regarding teaching about biomass production, from demographic information: (a) gender; (b) age; (c) years of teaching experience; (d) the highest degree; (e) levels taught; (f) subjects endorsed to teach in addition to agriculture; (g) membership of a selected professional organization; (h) attending any past workshops about biomass or bioenergy.

7. To identify factors underlying agriculture teachers' perceptions toward biomass production education.
8. To determine the proportion of variance in the teachers' perceptions that can be explained by these factors.

The previous chapter presented all the results and findings. To achieve the research objectives, this chapter discussed the indications of the results and findings. The discussion focused on the group level's perceptions, instead of individuals' perceptions.

Demographics of Respondents

The target population in this study was the agriculture teachers in Iowa's secondary schools. There were two hundred and forty seven teachers in the research population according to Iowa Agriculture Teachers Directory of 2013. Of the research population, one hundred teachers completed the survey instrument and returned it to the researchers involved in this study. The majority of the respondents (68%) were male teachers, and nearly one third (32%) were female teachers. This finding is consistent of the results from Feng's (2012) study that the majority of the teachers were male. Feng's (2012) study indicated females accounted for approximately twenty-five percentage of the total agriculture teachers in Iowa. Furthermore, a study in 2006 by Muma (2006) indicated that sixteen percent of the agriculture teachers were female. This finding indicates that the gender distribution of respondents in this study generally followed similar gender distribution of agriculture teachers in recent studies. In addition, the proportion of female agriculture teachers appears to have increased in recent years in

Iowa. This is an interesting finding and may have some long-term impacts on the curricula.

The average age of the respondents was 39.2. Respondents' age distribution was almost evenly distributed in each age stage, but the middle-age (30-60) was the dominant group. At the same time, young teachers had a significant proportion among all the agriculture teachers. Corresponding with the age distribution, beginning teachers with teaching experience less than five years also had a significant proportion of the total. In addition, senior teachers with teaching experience of more than twenty years accounted for one third of all the respondents, and well experienced teachers ($5 \leq$ teaching years ≤ 20) accounted for another one third. This finding indicated the overall Iowa agriculture teachers appears to be a team led by middle-aged experienced teachers with young and beginning teachers supporting the leaders.

Nearly half of the respondents had a teaching license endorsement for teaching biology along with teaching agriculture, and more than one third were endorsed to teach science. In addition, all the teachers acquired a bachelor's degree, and one third acquired a master's degree. At the same time, most respondents were involved in at least one professional organization affiliation. The findings reflected that the teachers were well educated professional educators, and presumably most teachers had a good science and education background to teach science related topics.

To apply Leu and Ginsburg's (2011) key principles of developing effective in-service education programs, those demographic findings are necessary. For instance, given that this group of teachers had a good educational background, teacher educators could accordingly adjust the depth of the training content. In addition, knowing that the average age of the agriculture teachers gets younger, the in-service training may consider using newer teaching technology, say Twitter, Evernote, Google Education, to improve the training quality and productivity. Furthermore, the in-service teacher education program should provide training on instructional strategies to help these beginning educators in their teaching skills.

The Positive Perceptions Regarding Biomass Production

Part I of the questionnaire was designed to achieve the first research objective: to describe the perceptions of agriculture teachers regarding biomass production. Across the twelve statements in the questionnaire Part I (Table X), the overall response toward each statement was positive (M >3.0), which indicated that these agriculture teachers, on average, had moderately to strong positive perceptions regarding biomass production. In addition to this general conclusion regarding this research objective, there are four specific implications.

A vast majority of the respondents (92%, n = 92) agreed to strongly agreed "using biomass for fuel can improve energy security". Just as scholars and researchers have optimistic attitudes about biomass (Iowa Corn Promotion Board, 2013; Yokoyama & Matsumura, 2008) and that biomass has become an important sustainable energy resource, most teachers in this study perceived biomass as an alternative energy resource.

Three statements: "Biomass production contributes to the local economy"; "biomass production contributes to the local job market"; "biomass production increases farmers' incomes", are all related to making an economic contribution. Each statement's positive responses accounted for 70% to 86% of the respondents, and indicated the teachers generally acknowledged the economic benefits from the production of biomass. This finding was supported by the recent literature (U.S. Energy Information Administration, 2013; Urbanchuk, 2013).

The teachers in the study showed moderate positive perceptions toward the statements related to environmental impacts from biomass production. Those statements are: “The use of biomass as energy helps to reduce greenhouse gas emissions”; “biomass production does not hurt the soil”; “biomass production does not hurt water resources”. Although the positive response rate of each statement was supported by more than 50% of the respondents, a significant proportion of responses (nearly 30%) were neutral, and the strongly positive response rate was only approximately 10%. The hesitation on the statements generally reflects the teachers’ uncertainty towards the environmental impact of biomass production. On one hand, the literature (Dominguez-Faus et al., 2009; Edwards et al., 2010) shows some potential threats to water and soil. Being aware of those threats might be one reason for the hesitation toward strong support. On the other hand, the uncertainty existed not only in the teachers’ perceptions regarding the greenhouse gas (GHG) emissions, but also in the current scientific research on the estimation of Biomass GHG emissions. Much research has been conducted to compare the biomass GHG emissions with fossil fuels, however the results have varied by researchers, because the GHG intensity of biomass derived energy is highly dependent on how the biomass is obtained and used (Curtright, Johnson, Willis, & Skone, 2012).

The literature has indicated that the farming practices and strategies for biomass use are different from the traditional food production practices (Schulte-Moore, Hall, Moore, Heaton, & Hallam, 2012). Grobbelaar (2010) and Wyman (1999) discussed many challenges were for biomass production including production costs, crop life-cycle environmental impacts, feedstock quality, co-products, and financing. Correspondingly, more than half of the respondents gave neutral or negative responses to the two statements: "The principles of biomass production are easy to understand" and "the technology of biomass production is easy to practice". The neural or negative perceptions are presumably attributed to the technical difficulties and unconventional farming practices. However, the findings reflect the potential educational need to learn more about those technical difficulties and unconventional farming practices. The interpretations of the response results were still positive.

In summary, the teachers' perceptions regarding biomass production are positive. According to the Theory of Reasoned Action (Ajzen & Fishbein, 1980) and research by Van Den Ban and Hawkins (1996), the teachers' positive perceptions regarding biomass production helped their positive behavioral intentions, and finally direct them to act positive behaviors facing stimuli related to biomass production.

The Positive Perceptions Regarding Teaching about Biomass Production

The second research objective was to describe the perceptions of agriculture teachers regarding teaching about biomass production, and Part II of the questionnaire (Table 9) was used to achieve this goal. The *means* (*M*) ranged from 3.06 to 4.01, which indicated, in general, teachers had moderately positive perceptions towards teaching about biomass production. In addition to this general conclusion, the responses towards this part of questionnaire provided several implications.

The literature (Meyer, 2010; Renner & McKeown, 2010; Iowa Workforce Development, n.d) has shown the booming bioenergy industry has provided more job opening, and the need for more development. More than sixty percent of the teachers agreed or strongly agreed with the statement "teaching about biomass production will help students with their careers". This finding indicated that most teachers have been aware of the workforce demand in the biomass energy industry, and they appear to be willing to teach biomass production for students' career opportunities. In addition, most teachers (> 80%) agreed to strongly agreed with the statement "teaching about biomass production is relevant to science education". This finding is in accordance with Hodson's (2003) advocacy that the topic of biomass production should be promoted in science education. In summary, the teachers acknowledged the positive impact of teaching about biomass production on student's education as well as career development in this area of curriculum.

The teachers slightly agreed with the statement "teaching about biomass production will be a challenge" (*M* = 3.26). However, most (85%) of the respondents agreed to have more training before teaching about biomass production (*M* = 4.01). The findings exhibit an obvious in-service educational need from the teachers. In addition, most (64%) of the teachers did not think teaching biomass production was significantly different from teaching crop production, and nearly half (49%) of the teachers believed it is easy to integrate the biomass production into the existing curriculum. Therefore, biomass production should be feasible to teach through the currently existing agriculture courses about crop production.

In summary, the agriculture teachers in the study had positive perceptions regarding teaching about biomass production, which represent the positive behavioral intentions in the model of TRA (Ajzen & Fishbein, 1980). Therefore, it is appropriate to suggest that the teachers would be willing to teach about biomass production in their courses.

Topics, Teaching Methods and Tools of Teaching about Biomass Production

The third research objective was to identify important topics focused on teaching about biomass production needed by agriculture teachers through in-service training. The fourth research objective was to identify the teaching methods and tools frequently used by Iowa agriculture teachers. The findings from both research objectives will be valuable information for developing in-service training programs for biomass production education. It is important that teachers are involved in the planning of both the structure and the content of in-service programs to ensure that their needs are being addressed (Leu, & Ginsburg, 2011).

Utilizing the Borich's (1980) needs assessment model, and analysis of Mean Weighted Discrepancy Score (MWDS), seven topics were recognized: (1) harvesting of biomass for sustainability, (2) selection of plant species for biomass production, (3) soil modification for biomass production, (4) farming systems including biomass, food crop, and livestock production, (5) basic procedures used to convert biomass to biofuel, (6) carbon cycle in biomass production, and (7) harvesting of biomass for profit. The seven topics have been examined by the agriculture teachers as important areas to teach about biomass production in their agriculture classes. At the same time, the teachers showed strong training needs for those topics.

By evaluating the frequency of using each teaching method or tool, thirteen teaching methods or tools were identified and ranked as follows: (1) discussion, (2) demonstration; (3) brainstorming; (4) on-line videos; (5) experiment; (6) lab session; (7) on-line articles; (8) field trips; (9) on-line data; (10) individualized instruction; (11) lecturing; (12) games and simulations; and (13) resource people.

These findings answered one of the most important questions in developing an in-service education program: what should be taught? In another words, the content of the program is addressed by the findings. The seven topics about biomass production education should be taught to increase their professional competence regarding biomass and production. In addition, the thirteen teaching methods or tools should be used to improve their teaching skills. Leu and Ginsburg's (2011) key principles for developing effective in-service education programs were addressed by answering this "what should be taught" question.

Influence on the Overall Perceptions regarding Teaching about Biomass

The results of the fifth objective of this study found that a positive moderate relationship existed between the overall perceptions regarding biomass production and the overall perceptions regarding teaching about biomass production (r =.441, p =.000). This finding successfully verified the Theory of Reasoned Action (Ajzen & Fishbein, 1980) that a positive perception on a subject will lead to a positive behavioral intention related to this subject. Similar relationships were also found in the past study by Sikinyi

(2003) on biotechnology and teaching about integrating biotechnology into agriculture curriculums; Koudinya and Martin (2010) on food safety and Kwaw-Mensah (2008) on livestock waste management.

However, the correlation was not as strong as the TRA's assumption. One reason may be caused by the limited response rate. The literature showed a bigger sample size can increase the accuracy of a correlational study (Dupont, & Plummer Jr, 1998). In addition, TRA does not include the behavioural control as another influence construct, which may contribute a certain proportion of variability to the correlation. Thus, the Theory of Planned Behavior (Ajzen 1991), included the behavioural control, might bring to find a stronger relationship between the overall perceptions regarding biomass production and the overall perceptions regarding teaching about biomass production.

The sixth research objective found a model existed between the overall perceptions regarding teaching about biomass and the demographic variables. 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". 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.

This model has two implications to teacher educators and researchers. One, the teachers naturally have a moderate perception regarding teaching about biomass production. This conclusion is consistent with the conclusion from *research objective 2*. Consequently, in general, the agriculture teachers in Iowa would be willing to teach biomass production. The other one, participation in workshop activities related to biomass or bioenergy, had a positive influence on the overall perceptions of teaching about biomass production. This conclusion is consistent with the workshop evaluation reports from Cenusa Bioenergy (2013). Thus, teachers are encouraged to participate more workshops related to bioenergy or biomass.

Factors underlying Agriculture Teachers' Perceptions toward Biomass Production Education

McCaslin and Torres (1992) indicated without knowing the factors underlying teachers' perceptions toward a subject, teacher educators lack important information to plan, design, and implement in-service programs. Research *objective 7* and *objective 8* were implemented to address this question. Based on the results of the research, it was concluded that four underlying factors accounted for approximately 60 percent of the variance in the teachers' perception regarding biomass production education. The factors were (1) social economic benefits, (2) environmental considerations, (3) students' learning confidence, and (4) student growth benefits.

The teachers' perceptions regarding biomass production education is mainly decided by those four factors. When planning and implementing in-service training programs, teacher educators should be aware of the four factors. First of all, the teachers should be taught what economic benefits the biomass production will bring to the society; what optimistic or undesirable environmental impacts will come along with the production of biomass; and what career and educational opportunities students can acquire from learning biomass production. In addition, though students' learning confidence is considered by the agriculture teachers as an important factor to make decisions about teaching biomass production, no known study has disclosed the relevant information. Consequently, researchers are encouraged to conduct a study on accessing students' learning confidence.

Summary

This chapter discussed all the findings in this study, discovered the implications, presented the connections between the findings and the literature, and provided the alternative explanations for the findings that are different from previous existing literature. Based on the discussion in this chapter, major conclusions, recommendations and overall summary are presented in the next chapter.

CHAPTER VI. SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Summary

Biomass has become an indispensable segment of the agriculture industry in Iowa (Iowa Energy Center, 2013). Higher incomes and numerous job positions were brought to Iowa residents by the biomass energy industry (Urbanchuk, 2013). The Iowa Workforce Development (n.d.) has reported a large and sustaining demand for the workforce in the biomass energy industry. Jennings and Lund (2001) have concluded that education is an essential foundation for the development of the biomass energy industry. One mission of agricultural education is to provide the workforce to meet the growth of global food, fiber, and energy needs (Doerfert, 2011). In addition, the topics related to biomass energy production have been suggested to add to K-12 school curricula to improve science education (Hodson, 2003). With an appeal to integrating science, technology, engineering and mathematics (STEM) education into agricultural education by Balschweid and Thompson (2002), topics related to biomass production might be a good pathway to improve students' STEM competencies in agricultural education programs. At the time when the study was being considered, there was no known study that indicated Iowa agriculture teachers have the intention of teaching biomass and biomass production in their agriculture courses. Without understanding the teachers' perceptions and beliefs about teaching a subject, it is hard to provide teachers with corresponding support to improve teaching and learning (Susuwele-Banda, 2005).

Purpose

The purpose of this study was to assess the perceptions of secondary school agriculture teachers in Iowa regarding biomass production education and the teachers' in-service needs regarding biomass production education. Eight research objectives were established:

1. To describe the perceptions of agriculture teachers regarding biomass production.
2. To describe the perceptions of agriculture teachers regarding teaching about biomass production.
3. To identify the biomass production topics needed by agriculture teachers through in-service training.
4. To identify the teaching methods and tools frequently used by agriculture teachers.
5. To determine the relationship between the overall perceptions regarding biomass production and the overall perceptions regarding teaching about biomass production.
6. To determine if a model exists predicting the overall perceptions regarding teaching about biomass production, from demographic information: (a) gender; (b) age; (c) years of teaching experience; (d) the highest degree; (e) levels taught; (f) subjects endorsed to teach in addition to agriculture; (g) membership of a selected professional organization; (h) attending any past workshops about biomass or bioenergy.

7. To identify factors underlying agriculture teachers' perceptions toward biomass production education.
8. To determine the proportion of variance in the teachers' perceptions that can be explained by these factors.

Procedures

This study was grounded in the Theory of Reasoned Action (Ajzen & Fishbein, 1980), and supported by Borich's (1980) needs assessment model, Gordon' s (1958) in-service teacher education program development principles as well as FAO's curriculum development model (Sawi, 1996). A set of questions with appropriate validity and reliability was developed as the research instrument. The target population, 247 secondary school agriculture teachers in Iowa, to whom the questionnaires were distributed. One hundred copies of completed questionnaires were returned to the researchers of this study. Data were processed and analyzed by the researcher using SPSS. Descriptive statistics, mean weighted discrepancy score, Pearson product- moment correlation coefficient, multiple regression analysis, and exploratory factor analysis were selected as the data analysis methods in this study.

Major Findings

The following statements summarize the major findings of this study:

1. The majority of agriculture teachers were males (68%), and proportion of females became larger than before.
2. Iowa agriculture teachers were a team-led by middle-aged experienced teachers, also encompassing young and beginning teachers.

3. Most teachers were well educated and had a strong science background.
4. Teachers, on average, agreed with statements supporting biomass production.
5. Teachers had strong positive perceptions about biomass production's contributions for energy resources and economic benefits.
6. Teachers showed some uncertainties about the environmental impact of biomass production.
7. Teachers were aware of the challenges presented by biomass production, and presented educational needs.
8. Teachers, on average, agreed with statements supporting teaching about biomass production.
9. Teachers acknowledged the positive impact of teaching about biomass production on student's education as well as careers.
10. Teachers recognized the difference between teaching about biomass production and teaching about regular crop production, but they thought it was feasible to integrate the biomass production education into the currently existing agriculture courses.
11. A positive moderate relationship was found between the overall perceptions regarding biomass production and the overall perceptions regarding teaching about biomass production.
12. A linear regression model existed between teachers' perceptions regarding teaching about biomass and teachers' experience of participating in a workshop related to biomass. The model shows: 1) Teachers naturally have a moderate perception regarding teaching about biomass production. 2)

Participation in workshop activities related to biomass or bioenergy had a positive influence on the overall perceptions of teaching about biomass production.

13. Seven biomass production topics were recognized as important and the need for training of agriculture teachers. The seven topics are: (1) harvesting of biomass for sustainability, (2) selection of plant species for biomass production, (3) soil modification for biomass production, (4) farming systems including biomass, food crop, and livestock production, (5) basic procedures used to convert biomass to biofuel, (6) carbon cycle in biomass production, and (7) harvesting of biomass for profit.
14. Thirteen teaching methods or teaching tools were frequently used by agriculture teachers: (1) discussion, (2) demonstration; (3) brainstorming; (4) on-line videos; (5) experiment; (6) lab session; (7) on-line articles; (8) field trips; (9) on-line data; (10) individualized instruction; (11) lecturing; (12) games and simulations; and (13) resource people.
15. Four factors underlay teachers' perceptions regarding biomass production education: (1) social economic benefits, (2) environmental considerations, (3) students' learning confidence, and (4) student growth benefits.

Conclusions

The following conclusions made from the findings of the study apply to the agriculture teacher population in Iowa:

1. Teachers have positively perceived biomass production. The positive perceptions mainly come from the social benefits brought by biomass, including: energy security, economy contribution, and job creations.
2. Environmental impact of biomass production is one important concern of perceiving biomass production, but the uncertainties of the environmental impacts weaken the teachers' positive perceptions regarding biomass production.
3. The challenges in understanding theoretical knowledge and mastering farming practice of biomass production have been realized by the teachers. The potential educational needs existed.
4. Teachers have positively perceived teaching about biomass production. The major motivation of teaching about biomass production is student growth benefits in further educational opportunities, career development, and science literacy.
5. Teachers tend to integrate teaching about biomass production with teaching about other crop production in agriculture courses.
6. Consistent with core principles of the Theory of Reasoned Action, the perceptions about biomass production are positively correlated with the intentions of teaching about biomass productions. Stronger intentions for teaching about biomass production will be formed when teachers positively

perceive biomass production. Participating in workshops related to bioenergy and biomass is one approach to improve the perceptions and consequently strengthen teaching intentions.

7. In-service training program are needed by teachers for teaching about biomass production. Teachers need more training about the biomass production topics: (1) harvesting of biomass for sustainability, (2) selection of plant species for biomass production, (3) soil modification for biomass production, (4) farming systems including biomass, food crop, and livestock production, (5) basic procedures used to convert biomass to biofuel, (6) carbon cycle in biomass production, and (7) harvesting of biomass for profit.
8. Several teaching methods and teaching tools are frequently used by agriculture teachers in Iowa: (1) discussion, (2) demonstration; (3) brainstorming; (4) on-line videos; (5) experiment; (6) lab session; (7) on-line articles; (8) field trip; (9) on-line data; (10) individualized instruction; (11) lecturing; (12) games and simulations; and (13) resource people.
9. Iowa agriculture teachers are well-educated, relatively young, with a decent science literacy background.

Implications: A Framework from Perceptions Investigation to In-service Program Development for Biomass Production Education

A framework was developed based upon the conclusions of this study. *Figure 5* presents this framework of this study. This framework demonstrated how the teachers' perceptions have been assessed and the procedures of gathering information to develop an effective in-service education program based on the teachers' perceptions and needs.

Four underlying factors including 1) social economic benefits, 2) environmental considerations, 3) students' learning confidence and 4) students' growth benefits have formed the teachers' positive perceptions regarding biomass production. The positive perceptions led the intentions of teaching about biomass production, applied with the Theory of Reasoned Action. Given the teaching intentions, needs assessment disclosed the important information to build the content and plan strategies for developing in-service training programs. The information includes teachers' background, teaching topics, teaching methods and tools as well as delivery methods. In addition, as a part of program development, knowing teachers' motivations is the key to engage the learners and improve teaching. The four factors underlying teachers' perceptions are also recognized as their motivations.

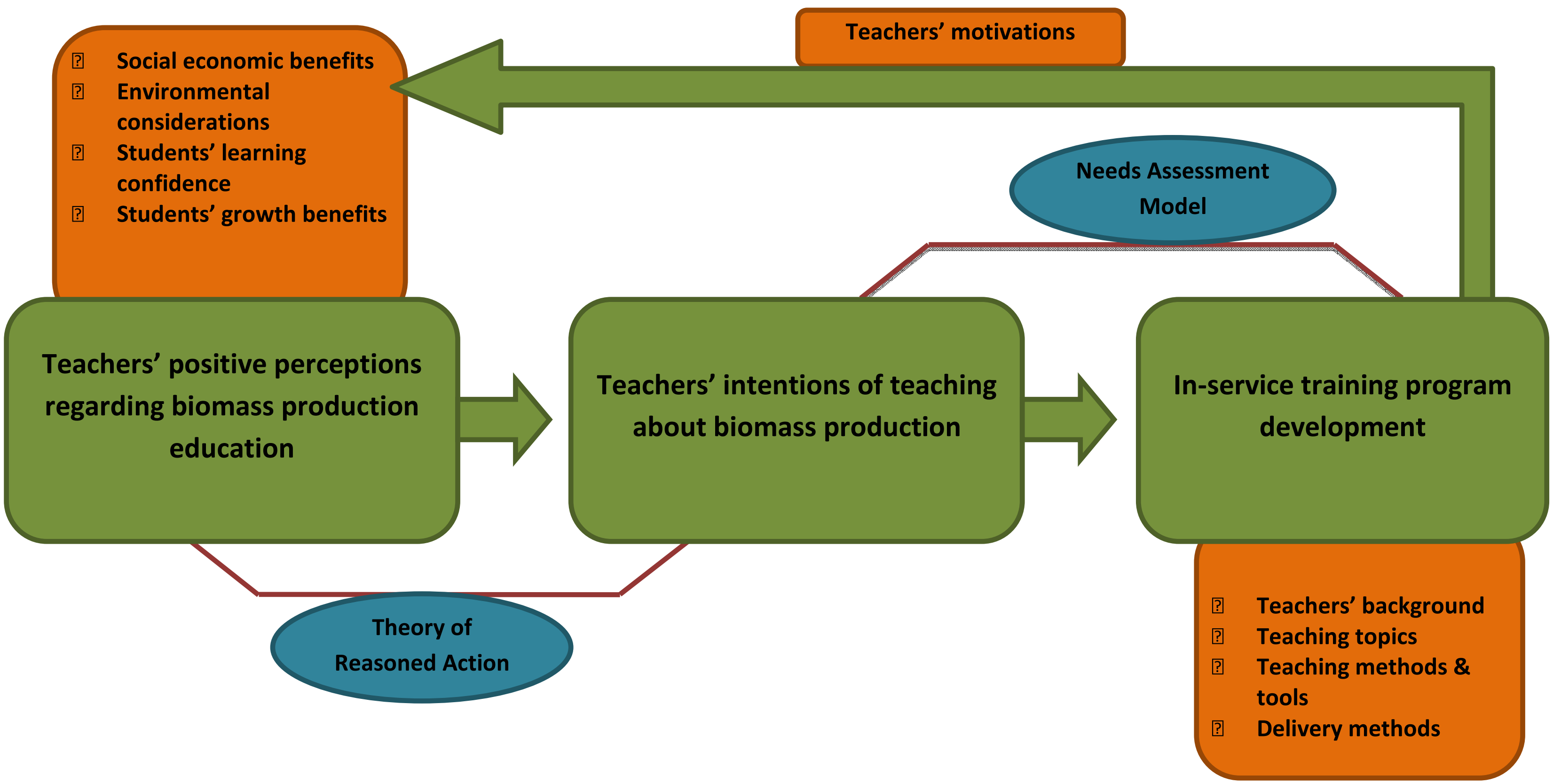

Figure 5. A framework from the investigation of perceptions to the development of in-service programs for biomass production education

Recommendations

Based on the conclusions of this study the following recommendations were made:

1. Agriculture teacher educators, researchers, superintendents should work together and develop in-service education programs to help teachers teach about biomass production.
2. Educators need to ensure the in-service program should cover the teaching topics, teaching methods, teaching tools and teaching motivations recognized through this study.
3. Teachers are encouraged to participate in more workshops or training programs related to biomass, bioenergy, or alternative energy topics.
4. Teacher educators should conduct a comprehensive review of studies related to the four underlying factors that would influence the teachers' perceptions, and present the facts to the teachers through in-service programs.
5. Teacher educators and researchers are recommended to develop fact sheets about the production of biomass, and facilitate discussions and debates on controversial topics related to biomass production.
6. For future correlational studies that involve identification/ investigation of teachers' perceptions, beliefs, attitudes, researchers are suggested to employ Theory of Planned Behavior (Ajzen 1991) as one theoretical framework to improve the accuracy of the correlations.

7. Researchers are recommended to conduct studies to learn more students' perceptions regarding learning about biomass production.
8. Researcher are encouraged to conduct similar studies by using the framework from perceptions investigation to in-service program development for biomass production education, and verify the feasibility and find the limitations of this framework.

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APPENDIX A. INSTITUTIONAL REVIEW BOARD APPROVAL FORM

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
1138 Pearson Hall
Ames, Iowa 50011-2207
515 294-4566
FAX 515 294-4267

Date: 6/11/2013

To: Guang Han
220 Curtiss Hall

CC: Dr. Robert Martin
201 Curtiss Hall

From: Office for Responsible Research

Title: Perception of Secondary School Agriculture Teachers Regarind Biomass Production Education in Iowa

IRB ID: 13-280

Study Review Date: 6/10/2013

The project referenced above has been declared exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b) because it meets the following federal requirements for exemption:

- (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey or interview procedures with adults or observation of public behavior where
  - Information obtained is recorded in such a manner that human subjects cannot be identified directly or through identifiers linked to the subjects; or
  - Any disclosure of the human subjects' responses outside the research could not reasonably place the subject at risk of criminal or civil liability or be damaging to their financial standing, employability, or reputation.

The determination of exemption means that:

- **You do not need to submit an application for annual continuing review.**
- **You must carry out the research as described in the IRB application.** Review by IRB staff is required prior to implementing modifications that may change the exempt status of the research. In general, review is required for any modifications to the research procedures (e.g., method of data collection, nature or scope of information to be collected, changes in confidentiality measures, etc.), modifications that result in the inclusion of participants from vulnerable populations, and/or any change that may increase the risk or discomfort to participants. Changes to key personnel must also be approved. The purpose of review is to determine if the project still meets the federal criteria for exemption.

  Non-exempt research is subject to many regulatory requirements that must be addressed prior to implementation of the study. Conducting non-exempt research without IRB review and approval may constitute non-compliance with federal regulations and/or academic misconduct according to ISU policy.

  Detailed information about requirements for submission of modifications can be found on the Exempt Study Modification Form. A Personnel Change Form may be submitted when the only modification involves changes in study staff. If it is determined that exemption is no longer warranted, then an Application for Approval of Research Involving Humans Form will need to be submitted and approved before proceeding with data collection.

Please note that you must submit all research involving human participants for review. **Only the IRB or designees may make the determination of exemption,** even if you conduct a study in the future that is exactly like this study.

Please be aware that **approval from other entities may also be needed.** For example, access to data from private records (e.g. student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. **An IRB determination of exemption in no way implies or guarantees that permission from these other entities will be granted.**

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.

IRB ID: 13-280

INSTITUTIONAL REVIEW BOARD (IRB)

Exempt Study Review Form

Title of Project: Perception of secondary school agriculture teachers regarding biomass production education in Iowa			
Principal Investigator (PI): **Guang Han**			Degrees: Master of Science
University ID: **429536107**	Phone: 321-609-1327	Email Address: guanghan@iastate.edu	
Correspondence Address: 220 Curtiss Hall, Iowa State University			
Department: Agricultural Education and Studies		College/Center/Institute: College of Agriculture and Life Science	

PI Level: ☐ Tenured, Tenure-Eligible, & NTER Faculty ☐ Adjunct/Affiliate Faculty ☐ Collaborator Faculty ☐ Emeritus Faculty ☐ Visiting Faculty/Scientist ☐ Senior Lecturer/Clinician ☐ Lecturer/Clinician, w/Ph.D. or DVM ☐ P&S Employee, P37 & above ☐ Extension to Families/Youth Specialist ☐ Field Specialist III ☐ Postdoctoral Associate ☒ Graduate/Undergrad Student ☐ Other (specify)

RECEIVED JUN 03 2013 By IRB

FOR STUDENT PROJECTS (*Required when the principal investigator is a student*)		
Name of Major Professor/Supervising Faculty: Dr. Robert Martin		
University ID: 045521366	Phone: 515-294-0896	Email Address: drmartin@iastate.edu
Campus Address: 201 Curtiss Hall, Iowa State University		Department: Agricultural Education & Studies
Type of Project: (check all that apply)	☒ Thesis/Dissertation	☐ Class Project ☐ Other (specify:)

Alternate Contact Person: None	Email Address:
Correspondence Address:	Phone:

ASSURANCE

- I certify that the information provided in this application is complete and accurate and consistent with any proposal(s) submitted to external funding agencies. Misrepresentation of the research described in this or any other IRB application may constitute non-compliance with federal regulations and/or academic misconduct.
- I agree to provide proper surveillance of this project to ensure that the rights and welfare of the human subjects are protected. I will report any problems to the IRB. See Reporting Adverse Events and Unanticipated Problems for details.
- I agree that modifications to the approved project will not take place without prior review and approval by the IRB.
- I agree that the research will not take place without the receipt of permission from any cooperating institutions, when applicable.
- I agree to obtain approval from other appropriate committees as needed for this project, such as the IACUC (if the research includes animals), the IBC (if the research involves biohazards), the Radiation Safety Committee (if the research involves x-rays or other radiation producing devices or procedures), etc.
- I understand that approval of this project does not grant access to any facilities, materials or data on which this research may depend. Such access must be granted by the unit with the relevant custodial authority.
- I agree that all activities will be performed in accordance with all applicable federal, state, local, and Iowa State University policies.

Guang Han 6/03/2013
Signature of Principal Investigator Date

Robert A. Martin 6-3-13
Signature of Major Professor/Supervising Faculty Date
(*Required when the principal investigator is a student*)

- I have reviewed this application and determined that departmental requirements are met, the investigator(s) has/have adequate resources to conduct the research, and the research design is scientifically sound and has scientific merit.

W. Wade Miller 6/3/13
Signature of Department Chair Date

For IRB Use Only	☐ Not Research Per Federal Regulations	☐ No Human Participants	Review Date: 6/10/2013
	☑ Minimal Risk	EXEMPT Per 45 CFR 46.101(b): 2	

Office for Responsible Research
Revised: 03/12/13

IRB Reviewer's Signature	Kelly A Agnitsch	June 10, 2013

Exempt Study Information

Please provide *Yes* or *No* answers, except as specified. Incomplete forms will be returned without review.

Part A: Key Personnel

List all members and relevant qualifications of the project personnel. Key personnel includes the principal investigator, co-principal investigators, supervising faculty member, and any other individuals who will have contact with the participants or the participants' data (e.g., interviewers, transcribers, coders, etc.). This information is intended to inform the committee of the training and background related to the specific procedures that each person will perform on the project. For more information, please see Human Subjects - Persons Required to Obtain IRB Training.

NAME	Interpersonal contact or communication with subjects, or access to private identifiable data?	Involved in the consent process?	Contact with human blood, specimens, or other biohazardous materials?	Other Roles in Research	Qualifications (i.e., special training, degrees, certifications, coursework, etc.)	Human Subjects Training Date
Guang Han	☐	☐	☐	Principal Investigator	National Institutes of Health Office's traning course "Protecting Human Research Participants"	02/17/2012
Robert Martin	☐	☐	☐	Major professor	Ph.D.	7/20/2000
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			

	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			

Please complete additional pages of key personnel as necessary.

PART B: FUNDING INFORMATION AND CONFLICTS OF INTEREST

☐ Yes ☒ No	**1.**	**Is or will the project be externally funded?**
		If ***No***, skip to question 8.
		If ***Yes***, please identify the type(s) of source(s) from which the project is directly funded. ☐ Federal agency ☐ State/local government agency ☐ University or School ☐ Foundation ☐ Other Non-Profit Institution ☐ For-Profit Business ☐ Other; specify: _____
☐ Yes ☒ No	**2.**	**Is ISU considered to be the Lead or Prime awardee for this project?**
☐ Yes ☒ No	**3.**	**Are there or will there be any subcontracts issued to others for this project?**
☐ Yes ☒ No	**4.**	**Is or will this project be funded by a subcontract issued by another entity?**
☐ Yes ☒ No	**5.**	**If ISU is the recipient of the subcontract, does it involve any federal funding, such as federal flow-through funds?**
6.		**If this project will be externally funded, please provide the complete name(s) of the funding source(s); please do not use acronyms.** If any subcontracts will be issued to others, please describe and include a list of all entities.
☐ Attached	**7.**	**Please attach a <u>complete and final copy</u> of the entire grant proposal or contract from which the project is or will be funded.**
☐ Yes ☒ No per 6/10/2013 email (initials)	**8.**	**Do or will any of the investigators or key personnel listed on this application have a conflict of interest management plan in place with the Office of the Vice President for Research & Economic Development?**

Part C: General Overview

Please provide a brief summary of the purpose of your study:
Investigate the high school agriculture teachers' perceptions about biomass production education, and assess their needs for in-service training about teaching biomass production.

Please provide a brief summary of your research design:
Descriptive survey, which includes five parts: 1) general perceptions about biomass production, 2) perceptions regarding teaching biomass production, 3) preferences of teaching methods and tools and 4) demographic infromation

Part D: Exemption Categories

☐ Yes ☒ No **1. Are you conducting research on Educational Practices (e.g., instructional techniques, curriculum effectiveness, etc.)? If *Yes*, please answer questions 1a through 1e. If *No*, please proceed to question 2.**

☐ Yes ☐ No **1a.** Will the research be conducted in an established or commonly accepted educational setting, such as a classroom, school, professional development seminar, etc.?

☐ Yes ☐ No **1b.** Will the research be conducted in any settings that would not generally be considered to be established or commonly accepted educational settings? If *Yes*, please specify: _____

☐ Yes ☐ No **1c.** Will the research procedures and activities involve normal educational practices (e.g., activities that normally occur in the educational setting)? Examples include research on regular or special education instructional strategies or the effectiveness of instructional techniques, curricula, or classroom management methods.

☐ Yes ☐ No **1d.** Will the research procedures include anything other than normal educational practices? If *Yes*, please specify: _____

☐ Yes ☐ No **1e.** Will the procedures include randomization into different treatments or conditions, radically new instructional strategies, or deception of subjects? If *Yes*, please specify: _____

☒ Yes ☐ No **2. Does your research involve use of educational tests, survey procedures, interview procedures, or observations of public behavior? If *Yes*, please answer questions 2a through 2c. If *No*, please proceed to question 3.**

☒ Yes ☐ No **2a.** Will the research involve one or more of the following? (Check all that apply.)

- ☐ The use of educational tests (cognitive, diagnostic, aptitude, achievement)
- ☒ Surveying or interviewing adults
- ☐ Observations of public behavior* of adults
- ☐ Observations of public behavior* of children, when the researcher will not interact or intervene with the children

*Note: Activities occurring in the workplace and school classrooms are not generally considered to involve public behavior.

☐ Yes ☐ No **2b.** Are all of the participants elected or appointed public officials or candidates for public office?

☐ Yes ☒ No **3. Does the research involve the collection or study of *currently existing* data, documents, records, pathological specimens, or diagnostic specimens? If *Yes*, please answer questions 3a through 3c. If *No*, please proceed to question 4.**

☐ Yes ☐ No **3a.** Are all of the data, documents, records, or specimens publicly available?

☐ Yes ☐ No **3c.** Will the data you record for your study include ID codes? If *Yes*, please answer 3ci and 3cii.

☐ Yes ☐ No **3ci.** Does a "key" exist linking the ID codes to the identities of the individuals to whom the data pertains?

☐ Yes ☐ No **3cii.** Will any persons on the research team have access to this key?

☐ Yes ☒ No **4. Does your research involve Taste and Food Quality tests and Consumer Acceptance Studies involving food? If *Yes*, please answer questions 4a through 4c. If *No*, please proceed to question 5.**

☐ Yes ☐ No **4a.** Is the food to be consumed normally considered wholesome, such as one would find in a typical grocery store?

☐ Yes ☐ No **4b.** If the food contains additives, are the additives at or below the level normally considered to be safe by the FDA, EPA or Food Safety and Inspection Service of USDA? Consider additives in commercially available foods found at a grocery store and/or any additives that are added to food for research purposes.

☐ Yes ☐ No **4c.** If there are agricultural chemicals or environmental contaminants in the food, are they at or below the level found to be safe by the FDA, EPA or Food Safety and Inspection Service of USDA?

☐ Yes ☒ No **5. Is your study a research or demonstration project to examine**

- **Federal public benefit or service programs such as Medicaid, unemployment, social security, etc.; or**
- **Procedures for obtaining benefits or service under these programs; or**
- **Possible changes in or alternatives to those programs or procedures; or**
- **Possible changes in methods or levels of payment for benefits or services under these programs?**

☐ Yes ☐ No **5a.** If *Yes*, is the research or demonstration project pursuant to specific federal statutory authority?

Part E: Additional Information

☐ Yes ☒ No **6. Does your research involve any procedures that do not fit into one or more of the categories in items #1–#5 listed above, such as the following? (Check all that apply.)**

- ☐ Usability testing of websites, software, devices, etc.
- ☐ Collection of information from private records when identifiers are recorded
- ☐ Procedures conducted to induce stress, moods, or other psychological or physiological reactions
- ☐ Presentation of materials typically considered to be offensive, threatening, or degrading
- ☐ Video recording or photographing non-public behaviors
- ☐ Use of deception (e.g., misleading participants about the procedures or purpose of the study)
- ☐ Physical interventions, such as
  - ☐ blood draws
  - ☐ new collection of biological specimens
  - ☐ use of physical sensors (ECG, EKG, EEG, ultrasound, etc.)
  - ☐ exercise, muscular strength assessment, flexibility testing
  - ☐ body composition assessment
  - ☐ measuring of height and weight
  - ☐ x-rays
  - ☐ changes in diet or exercise
- ☐ Tests of sensory acuity (i.e., vision or hearing tests, olfactory tests, etc.)
- ☐ Consumption of food (other than as described in #4) or dietary supplements
- ☐ Clinical studies of drugs or medical devices
- ☐ Other; please specify: _____

☐ Yes ☐ No **6a.** If *Yes*, is your research conducted in an established educational setting, and are the checked procedures part of normal educational practices given that setting? If *Yes*, please describe: _____

☐ Yes ☒ No **7. Do you intend or is it likely that your study will include any persons from the following populations? (Check all that apply.)**

- ☐ Prisoners
- ☐ Cognitively impaired

- [ ] Children (persons under age 18)
- [ ] Wards of the State
- [ ] Persons who are institutionalized

7 a. If *Yes*, please describe how they will be involved and what procedures they will complete: ____

[ ] Yes [X] No **8. Will any of the following identifiers be *linked to the data* at any time point during the research? (Check all that apply.)**

- [ ] Names: [ ] First Name Only [ ] Last Name Only [ ] First and Last Name
- [ ] Phone/fax numbers
- [ ] ID codes that can be linked to the identity of the participant (e.g., student IDs, medical record numbers, account numbers, study-specific codes, etc.)
- [ ] Addresses (email or physical)
- [ ] Social security numbers
- [ ] Exact dates of birth
- [ ] IP addresses
- [ ] Photographs or video recordings
- [ ] Other; please specify: ____

[ ] Yes [X] No **9. Is there a reasonable possibility that participants' identities could be ascertained from any combination of information in the data? If *Yes*, please describe:** ____

10. If *Yes* to *either* #8 or #9 above, please answer the following:

[ ] Yes [ ] No **10a. Will participants' identities be kept confidential when results of the research are disseminated?**

[ ] Yes [ ] No **10b. Could any of the information collected, if disclosed outside of the research, reasonably place the subjects at risk of any of the following? (Check all that apply.)**

- [ ] Criminal liability
- [ ] Civil liability
- [ ] Damage to the subjects' financial standing
- [ ] Damage to the subjects' employability
- [ ] Damage to the subjects' reputation

[ ] Yes [ ] No **10c. Does the research, directly or indirectly, involve or result in the collection of any information regarding any of the following? (Check all that apply.)**

- [ ] Use of illicit drugs
- [ ] Criminal activity
- [ ] Child, spousal, or familiar abuse
- [ ] Mental illness
- [ ] Episodes of clinical depression
- [ ] Suicidal thoughts or suicide attempts
- [ ] Health history
- [ ] History of job losses
- [ ] Exact household income other than in general ranges
- [ ] Negative opinions about one's supervisor, workplace, teacher, or others to whom the subject is in a subordinate position
- [ ] Opinions about race, gender, sexual orientation, or any other socially sensitive or

controversial topics
☐ Sexual preferences or behaviors
☐ Religious beliefs
☐ Any other information that is generally considered to be private or sensitive given the setting of your research; if so, please specify: _____

After completion of Parts A, B, and C of this application, please send the completed form to:

Institutional Review Board (IRB)
Office for Responsible Research
1138 Pearson Hall
Ames, IA 50011-2200

Data collection materials (e.g., survey instruments, interview questions, recruitment and consent documents, etc.) do not need to be submitted with this application.

If you have any questions or feedback, please contact the IRB office at IRB@iastate.edu or 515-294-4566.

APPENDIX B. QUESTIONNAIRE IN HARD COPY

PART I - General perceptions regarding biomass and biomass production

The following statements are related to general perceptions regarding biomass and biomass production. Please circle your level of agreement on the 5 point Scale provided.

Key for level of agreement
SD= Strongly Disagree
D= Disagree
N= Neutral
A= Agree
SA= Strongly Agree

Statement	Level of agreement
1. Using biomass for fuel can improve energy security.	SD D N A SA
2. Biomass has helped lower the price of oil.	SD D N A SA
3. The federal government supports the development of biomass production.	SD D N A SA
4. Biomass production contributes to the local economy.	SD D N A SA
5. Biomass production contributes to the local job market.	SD D N A SA
6. Biomass production increases farmers' incomes.	SD D N A SA
7. The use of biomass as energy helps to reduce greenhouse gas emissions.	SD D N A SA
8. Biomass production hurts the soil.	SD D N A SA
9. Biomass production hurts water resources.	SD D N A SA
10. Biomass production threatens food security.	SD D N A SA
11. The principles of biomass production are easy to understand.	SD D N A SA
12. The technology of biomass production is easy to practice.	SD D N A SA

PART II- Perceptions regarding teaching about biomass production

The following statements are related to perceptions regarding teaching about biomass production. Please circle your level of agreement on the 5 point Scale provided.

Key for level of agreement
SD= Strongly Disagree
D= Disagree
N= Neutral
A= Agree
SA= Strongly Agree

Statement	Level of agreement
1. Agriculture teachers should be experts in biomass production.	SD D N A SA
2. Teaching about biomass production is relevant to science education.	SD D N A SA
3. Teaching about biomass production will help students with their careers.	SD D N A SA
4. Teaching about biomass production will help students with future higher education.	SD D N A SA
5. Teaching about biomass production is easy to integrate into the existing curriculum.	SD D N A SA
6. Teaching about biomass production should be delivered in a course format.	SD D N A SA
7. Students want to learn about biomass production.	SD D N A SA
8. Teaching about biomass production will be a challenge for the teacher.	SD D N A SA
9. More training will be needed for agriculture teachers before teaching about biomass production.	SD D N A SA

10. There is no significant difference between teaching about regular crop (food) production and biomass production.	SD D N A SA

PART III - The importance of selected topics in biomass production education and the need for more information on the topic

Given below are selected topics related to biomass production education. Please circle the degree of importance of this topic to your agriculture curriculum on the 5 point scale provided on the left column. In addition, please circle the degree of need for more information on the topic on the 4 point scale provided on the right column.

Key for level of importance
1= Very unimportant
2= Unimportant
3= Neutral
4= Important
5= Very important

Key for degree of need
1= No need at all
2= Slight need
3= Moderate need
4= High need

Topics Related to Biomass Production Education	Level of importance	Degree of your need for more information on the topic
Biological material for biomass	1 2 3 4 5	1 2 3 4
Selection of plant species for biomass production.	1 2 3 4 5	1 2 3 4
Biomass feedstock	1 2 3 4 5	1 2 3 4
The use of biomass feedstock	1 2 3 4 5	1 2 3 4
Carbon cycle in biomass production.	1 2 3 4 5	1 2 3 4
Soil modification for biomass production	1 2 3 4 5	1 2 3 4
Farming systems including biomass, food crop, and livestock production.	1 2 3 4 5	1 2 3 4
Marketing information about biomass	1 2 3 4 5	1 2 3 4
Harvesting of biomass for profit.	1 2 3 4 5	1 2 3 4
Harvesting of biomass for	1 2 3 4 5	1 2 3 4

sustainability.									
Policy issues related to biomass.	1	2	3	4	5	1	2	3	4
Basic procedures used to convert biomass to biofuel.	1	2	3	4	5	1	2	3	4
The history of bioenergy and the related biomass.	1	2	3	4	5	1	2	3	4
Other (Please specify)______________________	1	2	3	4	5	1	2	3	4
Other (Please specify)______________________	1	2	3	4	5	1	2	3	4

PART IV - Use of teaching methods and tools

We are interested in knowing the teaching methods or tools you like to use in teaching agriculture. Please circle the extent you like to use the teaching methods or tools on the 3 point scale provided.

Key for the extent you like to use these methods or tools
1= Do not use
2= Occasionally use
3= Often use

Methods/ Tools	The extent that you like to use these methods or tools		
Lecturing	1	2	3
Discussion	1	2	3
Case studies	1	2	3
Demonstration	1	2	3
Individualized instruction	1	2	3
Brainstorming	1	2	3
Role play	1	2	3
Field trip	1	2	3
Lab session	1	2	3
Debate	1	2	3
Experiment	1	2	3
Games and simulations	1	2	3

Supervised study	1	2	3
Resource people	1	2	3
Webinar	1	2	3
On-line data	1	2	3
On-line articles	1	2	3
On-line videos	1	2	3
Other (Please specify)______________________	1	2	3
Other (Please specify)______________________	1	2	3
Other (Please specify)______________________	1	2	3

PART V - Demographic Information

1. *Please circle your gender?* *Male* *Female*
2. *What's your age?* ______________________
3. *How many years have you been teaching?* ______________________
4. *What's your highest academic degree?* ______________________
5. *What the grade level(s) do you teach?* ______________________

6. Please circle the areas you are endorsed to teach:

Agriculture *Biology*

Science *Chemistry*

Physics *Industrial Arts*

Other (Please indicate):

____

7. Are you a member of any agricultural education organization?

□*Yes* □*NO*

If yes, please indicate:

____

8. Have you participated in any workshop or training program about bioenergy or biomass?

□*Yes* □*NO*

If yes, do you think the training was adequate for you to teach about the topic area?

□*Yes* □*NO*

9. Please circle the preferred delivery approach for the in-service training of teaching about biomass production:

□Face to face workshop

□Webinar

□Other (Please indicate)

____

10. Please give any additional comments you may have regarding biomass production education:

*Comments:*____

____

____

____

____

Thank you for your participation

Please return the questionnaire to the investigators

APPENDIX C. QUESTIONNAIRE IN ELECTRIC COPY (BY QUALTRICS)

Default Question Block

Perceptions of secondary school agriculture teachers regarding biomass production education in Iowa

The purpose of this study is to determine the perceptions of agriculture teachers in secondary schools regarding teaching about biomass production in Iowa. To achieve this purpose, we have chosen to use a questionnaire. We are interested in knowing your perceptions regarding biomass production, teaching about it, its importance and your preferred teaching methods.

Your confidentiality is assured. We are only interested in group data. Individual data will not be shared. This study will be used to complete a Master's degree, and the results of this study will be shared with Iowa agriculture teachers.

This study has been approved by Institutional Review Board (IRB) of Iowa State University. For more information, please visit: http://www.compliance.iastate.edu/irb/

If you have any questions about this study, please contact the investigators:

Guang Han guanghan@iastate.edu
Dr. Robert Martin drmartin@iastate.edu

It will take you about 5-10 minutes to complete this questionnaire. Thank you for your cooperation.

Background Information

Biomass currently supplies about 3% of the total U.S. energy consumption in the form of electricity, process heat, and transportation fuels—all of which help to diversify the nation's energy supply and support rural economies. More and more energy companies are increasing the amount of electricity and fuels produced from renewable energy resources in response to consumer demand and policy incentives (Biomass Program, U.S. Department of Energy).

Biomass typically refers to organic material such as various plants and grain, crop waste, trees, wood waste and animal waste. Some examples of biomass include wood chips, corn, corn stalks, soybeans, switchgrass, straw, animal waste and food-processing by-products (Iowa Energy Center, 2013).

Biomass production namely is the production of biomass. In Iowa, biomass consists of crop production, grass production, wood production, animal product production, and agriculture residues & other waste (Brown, 1994).

The survey for this research once had been distributed on the
2013 Summer Conference of IOWA ASSOCIATION OF AGRICULTURAL EDUCATORS.

Have you attended the Iowa Ag Teacher Summer Conference (June 25-27th 2013) held at DMACC's FFA Enrichment Center in Ankeny, IA?

- Yes
- No

During the Conference, have you filled out a survey about biomass production education printed on bright green papers and distributed by researchers from Iowa State University?

- Yes
- No

PART I - General perceptions regarding biomass and biomass production

The following statements are related to general perceptions regarding biomass and biomass production. Please indicate your level of agreement with each statement by clicking the appropriate button on the 5 point scale provided.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.Using biomass for fuel can improve energy security.	○	○	○	○	○
2. Biomass has helped lower the price of oil.	○	○	○	○	○
3. The federal government supports the development of biomass production.	○	○	○	○	○
4. Biomass production contributes to the local economy.	○	○	○	○	○
5. Biomass production contributes to the local job market.	○	○	○	○	○
6. Biomass production increases farmers' incomes.	○	○	○	○	○
7. The use of biomass as energy helps to reduce greenhouse gas emissions.	○	○	○	○	○
8. Biomass production **hurts** the soil.	○	○	○	○	○
9. Biomass production **hurts** water resources.	○	○	○	○	○
10. Biomass production **threatens** food security.	○	○	○	○	○

11. The principles of biomass production are easy to understand. ○ ○ ○ ○ ○

12. The technology of biomass production is easy to practice. ○ ○ ○ ○ ○

PART II- Perceptions of teaching about biomass production

The following statements are related to perceptions regarding teaching about biomass production. Please indicate your level of agreement with each statement by clicking the appropriate button on the 5 point scale provided.

Strongly Disagree	Disagree	Neutral/ Unsure	Agree	Strongly Agree
1. Agriculture teachers should be experts in biomass production.				
○	○	○	○	○
2. Teaching about biomass production is relevant to science education.				
○	○	○	○	○
3. Teaching about biomass production will help students with their careers.				
○	○	○	○	○
4. Teaching about biomass production will help students with future higher education.				
○	○	○	○	○
5. Teaching about biomass production is easy to integrate into the existing curriculum.				
○	○	○	○	○
6. Teaching about biomass production should be delivered in a course format.				
○	○	○	○	○
7. Students want to learn about biomass production.				
○	○	○	○	○
8. Teaching about biomass production will be a challenge for the teacher.				
○	○	○	○	○
9. More training will be needed before teaching about biomass production.				
○	○	○	○	○
10. There is **no significant difference** between teaching about regular crop (food) production and biomass production.				
○	○	○	○	○

PART III - The importance of selected topics in biomass production education and the need for more information on the topic

Given below are selected topics related to biomass production education. Please indicate the degree of importance of this topic to your agriculture curriculum, by clicking the appropriate button on the 5 point scale provided on the left column. In addition, please indicate the degree of need for more information on the topic, by selecting the appropriate option on the 5 point scale provided on the right column. In addition to the topics that have been listed, please indicated other important topic(s) in your mind, and indicate the level of need for more information on it (them).

	Level of Importance					Tea inf
	Very unimportant	Unimportant	Neutral/Unsure	Important	Very important	
Biological material for biomass	○	○	○	○	○	
Selection of plants for biomass production.	○	○	○	○	○	
Biomass feedstock	○	○	○	○	○	
The use of biomass feedstock	○	○	○	○	○	
Carbon cycle in biomass production.	○	○	○	○	○	
Soil modification for biomass production	○	○	○	○	○	
Farming systems including biomass, food crop, and livestock production.	○	○	○	○	○	
	Very unimportant	Unimportant	Neutral/Unsure	Important	Very important	
Marketing information about biomass	○	○	○	○	○	
Harvesting of biomass for profit.	○	○	○	○	○	
Harvesting of biomass for sustainability.	○	○	○	○	○	
Policy issues related to biomass.	○	○	○	○	○	
Basic procedures used to convert biomass to biofuel.	○	○	○	○	○	
The history of bioenergy and the related biomass.	○	○	○	○	○	

Please indicate other important topics related to teaching about biomass production in you minds, and plese also indicatethe level of needs of the corresponding information (Optional).

PART IV - Use of teaching methods and tools

We are interested in knowing the teaching methods or tools you like to use in teaching agriculture. Please circle the extent you like to use the teaching methods or tools on the 2 stars scale provided.

No Star: Do not use
1 Star: Occasionally use
2 Stars: Often use

Lecturing

Discussion

Case studies

Demonstration

Individualized instruction

Brainstorming

Role play

Field trip

Lab session

Debate

Experiment

Games and simulations

Supervised study

Resource people

Webinar

On-line data

On-line articles

On-line videos

Other (Please indicate)

Other (Please indicate)

PART V - Demographic Information

Please indicate your gender:

Please indicate your age:

How many years have you been teaching? Please circle the appropriate year.

Please mark the grade levels you teach:

- ☐ 7
- ☐ 8
- ☐ 9
- ☐ 10
- ☐ 11
- ☐ 12
- ☐ Other (Please indicate)

Please indicate your highest level of education:

- ◯ High school degree
- ◯ Associate bachelor degree
- ◯ Bachelor degree
- ◯ Master degree
- ◯ Doctor degree
- ◯ Other (please indicate)

Which of the following areas are you endorsed to teach? Please choose all the suitable items.

- ☐ Agriculture
- ☐ Biology
- ☐ Science
- ☐ Chemistry
- ☐ Physics
- ☐ Industrial Arts
- ☐ Other (Please indicate)
- ☐ Other (Please indicate)
- ☐ Other (Please indicate)
- ☐ Other (Please indicate)

Are you a member of any agricultural education organization?

- ○ Yes
- ○ No

If yes, Please indicate

Have you participated in any workshop or training program about bioenergy or biomass?

- ○ Yes
- ○ No

If yes, do you think the training was adequate for you to teach about the topic area?

- ○ Yes
- ○ No

Which delivering approach do you prefer for the in-service training for teaching biomass production? Please circle the most appropriate item.

- ☐ Face to face workshop
- ☐ Webinar
- ☐ Other (Please indicate)
- ☐ Other (Please indicate)

Please give any additional comments you may have regarding biomass production education :
Comments:

Thank you for your participation. Appreciate you time!

APPENDIX D. COVER LETTER OF THE QUESTIONNAIRE

Perceptions of secondary school agriculture teachers regarding biomass production education in Iowa

The purpose of this study is to determine the perceptions of agriculture teachers in secondary schools regarding teaching about biomass production in Iowa. To achieve this purpose, we have chosen to use a questionnaire. We are interested in knowing your perceptions regarding biomass production, teaching about it, its importance and your preferred teaching methods.

Your confidentiality is assured. We are only interested in group data. Individual data will not be shared. This study will be used to complete a Master's degree, and the results of this study will be shared with Iowa agriculture teachers.

This study has been approved by Institutional Review Board (IRB) of Iowa State University. For more information, please visit: http://www.compliance.iastate.edu/irb/

If you have any questions about this study, please contact the investigators:

Guang Han guanghan@iastate.edu

Dr. Robert Martin drmartin@iastate.edu

It will take you about 10-15 minutes to complete this questionnaire. Thank you for your cooperation.

Background Information

Biomass currently supplies about 3% of the total U.S. energy consumption in the form of electricity, process heat, and transportation fuels—all of which help to diversify the nation's energy supply and support rural economies. More and more energy companies are increasing the amount of electricity and fuels produced from renewable energy resources in response to consumer demand and policy incentives (Biomass Program, U.S. Department of Energy).

Biomass typically refers to organic materials such as various plants and grains, crop waste, trees, wood wastes and animal wastes. 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).

Biomass production namely is the production of biomass. In Iowa, available biomass resources include commodity crops, energy crops such as switchgrass, woody perennials, animal by-products such as manure, and agriculture residues & other waste (Brown, 1994).

APPENDIX E. ORIGINAL DATA OF OPBP AND OPTBP

No. of Observation	OPBP	OPTBP	No. of Observation	OPBP	OPTBP	No. of Observation	OPBP	OPTBP
1	4.42	3.56	40	3.67	3.56	79	4.33	3.33
2	3.92	4.44	41	3.17	2.56	80	3.25	3.56
3	3.92	2.89	42	4	3.44	81	3.5	2.78
4	4.33	3.56	43	3.42	2.67	82	3.25	3.44
5	3.58	3.67	44	4	3.33	83	3.58	3.89
6	2.75	3.33	45	4.75	4.33	84	3.25	3.44
7	3.58	3.33	46	3.25	3.44	85	3.5	3.33
8	3.42	3.33	47	3.25	3.33	86	3.75	3.44
9	3.25	3	48	3.58	3.22	87	3.33	2.89
10	4	3.22	49	3.42	3.33	88	3.42	3.44
11	3.17	3.22	50	3.92	3.22	89	4.08	4.11
12	3.5	3.56	51	3.58	3.44	90	3.17	3.78
13	3.67	3.11	52	3.33	3.44	91	3.92	3.78
14	4.08	3.33	53	3.17	3.22	92	3.75	3.33
15	3	3.11	54	3.75	3.44	93	3.5	2.78
16	3.92	4	55	3.17	2.78	94	3.58	2.11
17	3.67	3.56	56	3.5	3.33	95	3.67	3.78
18	2.92	3.56	57	3.75	4	96	2.83	2.56
19	3.5	3.11	58	3.67	3.33	97	3.67	3.33
20	3.92	4	59	3.25	3.33	98	4.42	3.56

21	4	3.56
22	3.5	3.11
23	3.25	3.44
24	3.5	3.44
25	3.75	3.22
26	3.83	3.56
27	3.67	3.56
28	3.75	3
29	3.67	3.33
30	3.67	3.11
31	3.67	3.33
32	3.67	3.33
33	3.58	3.11
34	4.42	3.22
35	2.92	3.11
36	3.92	3.33
37	3.92	3.78
38	3.42	3.22
39	3.33	3.33

60	3.33	3.22
61	3.83	3.44
62	3.83	3.22
63	3.67	3.67
64	3.67	3.56
65	3.25	3.44
66	4.17	3.89
67	3.42	3.22
68	3.92	3.56
69	3.67	3.33
70	4.75	3.78
71	4.25	3.67
72	3.67	3.56
73	3.5	3.89
74	3.83	3.22
75	3.83	3.67
76	3	2.67
77	4.5	3.67
78	3.58	3.56

99	4	3.44
100	3.75	3.33