1 Introduction

Study efforts on renewable sources of energy have primarily focused on investigating new technologies for the production of biofuels [1-5]; the economic potential of biofuel resources [6-7]; market development decisions of bioenergy processors and biomass producers [8]; as well as farmers’ behavior, attitudes, and information needs towards potential adoption of feedstocks for biofuel production [9-13]. However, little effort has gone into studying the ability of extension educators and other outreach agents to provide technical assistance and guidance for farmers and agribusiness seeking to enter into biofuel feedstock production.

Outreach and education programs are critical for the dissemination of information to key stakeholders. Extension and outreach provides a myriad of services including: (i) research and information on critical and emerging issues relevant to stakeholders; (ii) establishment of partnerships and collaborations between stakeholders to solve local problems; (iii) engagement with stakeholders to develop, implement and evaluate programs and strategies to solve local problems; (iv) promote adoption of best management practices; and (v) educational programs that help to improve economic, social and environmental conditions [14]. Stakeholders include farmers, ranchers, agribusinesses, industry, civic organizations, consumers and government. In the context of biofuel feedstock production, these services may include dissemination of research about viable feedstocks that can be used to produce biofuels in different geographic locations (e.g. [15]); educational programs to provide interactive learning about agronomic and economic aspects of biofuel feedstock production and start-up (e.g. https://cenusa.iastate.edu); and technical assistance with the development and planning of a biofuel feedstock enterprise.

Despite the availability of other information sources, farmers and landowners still prefer one-on-one
interaction with extension agents to obtain information to manage their farms and land resources [12]. As a result, extension educators and other outreach agents can play an active role designing and conducting training activities, bringing together key stakeholders, and helping communities to understand the economic and environmental opportunities of biofuels and biofuel feedstock production [16-19], which is vital for the development of local bio-energy markets in the US [20]. Farmers and agribusiness still have much to learn and explore about the formation and establishment of markets for biofuel feedstocks [9,21]. The current market for production of biofuels from cellulose feedstocks has remained well below government mandated targets due to uncertainty and limited understanding of the market [20,22].

Understanding feedstocks and biofuel production can help farmers identify the benefits and risks of growing alternative feedstocks, and be aware of potential future agricultural markets. Similarly, local and regional government officials can begin to understand the potential economic impacts (e.g. increasing employment) on local economies resulting from bioenergy development [19]. The challenge remains on how to provide farmers, government, and other agribusiness with needed and relevant information on feedstocks and biofuels to fulfill the requirements of this growing industry.

The purpose of this paper is to assess Extension and outreach education levels in the western United States. The paper presents results of a survey administered to extension educators and other outreach personnel in 10 western states of the U.S. The objective of the survey was to assess the current state of knowledge of extension educators and their needs regarding feedstocks and biofuel production, as well as the mechanisms they use for outreach to their clientele. The specific purpose here is to determine the learning and educational delivery methods Extension agents and other outreach partners prefer in obtaining and providing new information on feedstocks and biofuel production, and their current level of knowledge concerning biofuel and feedstocks production. Findings will allow recognition of potential barriers that need to be overcome for development of biofuel feedstock markets, and identifying new outreach efforts to provide the needed capacity as the bioenergy industry continues to grow.

2 Data and methods

An online survey was offered to extension personnel, agribusinesses, seed dealers, agricultural consultants, researchers and government agency personnel. The questionnaire contained 34 questions organized in three sections. The first section gathered information on occupation and demographics; the second requested information about outreach and extension methods currently used by the respondents; and the third section focused on assessing current knowledge and perceptions respondents have about feedstocks and biofuel production and markets.

The questionnaire was emailed to 7,612 extension and outreach personnel across ten states in the western U.S. on December, 2012 (see Table 1). Email addresses for the survey sample were obtained publically and included: (i) research scientists and extension personnel at land grant universities; (ii) research scientists and service personnel working for the U.S. Department of Agriculture (Natural Resource Conservation Service and Farm Service Agency); and (iii) scientists, crop consultants, and other outreach agents in the agribusiness sector. All of these agents play a significant role in providing extension education and outreach to stakeholders about feedstock and biofuel production. The focus on the western U.S. was due to the strong potential for biofuel feedstock production in these western states.

A total of 989 responses were received (a response rate of 13%). For purposes of this paper, 143 observations were dropped from the dataset since they did not contain needed information about outreach extension methods and/or biofuels. Descriptive statistics were obtained using Stata/IC 12.1 econometric software and Microsoft EXCEL. Each question of the survey was analyzed by outreach sector and by region. The three sectors were: 1) extension and research, 2) government, and 3) agribusiness. The government sector refers to personnel who work in the U.S. Department of Agriculture, the extension and research sector contains all of those who work as state or county extension agents, as well as university, government (including USDA) and industry researchers. Finally, seed suppliers or dealers, chemical dealers, crop consultants, certified crop advisors and other agribusiness were

| Pacific Northwest         | Prairie Gateway | Northern Great Plains |
|---------------------------|-----------------|-----------------------|
| Fruitful Rim N=130        | N=433           | N=255                 |
| California                | Colorado        | Minnesota             |
| Idaho                     | Kansas          | Montana               |
| Oregon                    | Nebraska        | North Dakota          |
| Washington                | Oklahoma        | South Dakota          |
|                           | Texas           |                       |

Table 1: States surveyed and their classification into regions
grouped under the agribusiness sector. As shown in Table 1, the 10 western states surveyed were grouped in three regions: the Pacific Northwest Fruitful Rim, the Prairie Gateway, and the Northern Great Plains region. Prairie Gateway was the region with the highest response rate, obtaining 51% of the total responses. Kansas, Colorado, and Nebraska were the states with the highest response, representing 17%, 10.64%, and 10.17% of the total responses, respectively. The lowest rate corresponds to the Pacific Northwest Fruitful Rim region where California and Oregon contributed only 1.18% each, of the total responses obtained.

3 Results

Most of the respondents had a bachelor, masters, or doctoral degree. Between 6 and 8 percent of the respondents have taken graduate course work and less than 7 percent stated to have only a vocational, associates, or high school degree. The Pacific Northwest region had the highest rate of agents holding master’s and doctoral degrees (36.92% and 20.77%, respectively) while the Prairie Gateway and Northern Great Plains had the highest rate of agents holding a bachelor’s degree (40.88% and 48.63%, respectively).

For all regions, the majority of respondents considered crop production as their primary area of expertise. This area involves activities such as: agronomy and soils, horticulture, pesticides and integrated plant management, production management, and livestock production. A very low percentage of respondents were involved in business, marketing, and/or finance and insurance activities.

As shown in Figure 1, on a Likert scale from 1 (strongly disagree) to 5 (strongly agree), respondents were asked what agricultural stakeholders they frequently work with in their positions. Showing averages greater than 3.4 (between indifferent to strongly agree), respondents in both the agribusiness and the extension and research sectors affirmed they frequently work with farmers and agribusiness, while those in the government work mainly with farmers. Only respondents in the agribusiness sector in the Pacific region and those in the extension and research sector in the Northern Great Plains affirmed to work with commodity groups, showing a mean greater than 3.5.

Figure 2 provides statistics on what sources extension educators and agents found effective to obtain needed crop information, which is important when considering

![Figure 1: Target stakeholder group interactions and reception of information perception by extension and outreach agents in the western U.S. Statistics are the mean across responses on a Likert scale: 1= strongly disagree, 2= disagree, 3= neither agree nor disagree, 4= agree, and 5= strongly agree. (N = 846)](image)
many biofuel feedstocks are annual and perennial crops. Extension educators and other outreach personnel ranked university extension publications, internet, and newsletters between somewhat effective and very effective, showing a mean higher than 2.7, on average. Research experiment station publications and federal agricultural agencies were sources considered effective to very effective (mean higher than 3) by the extension/research and government sectors, respectively. The least effective sources were seed company publications, farmers’ organizations, and other industry publications.

Respondents were asked to rank the top three events they attend to learn about agricultural production (Figure 3). These events are important as they are critical linkages for scientists and researchers to disseminate their knowledge and findings to extension and outreach agents. Conferences, meetings, and field days were the events most frequently ranked, having more than 46% of respondents attending these events. Furthermore, between 20 to 40% of respondents ranked extension websites, on-farm demonstrations, and interactive workshops as events extension educators and other outreach personnel attend or use to obtain agricultural information. Seed company events and university classes were the events least used and attended.

Regarding outreach methods for disseminating information and knowledge, extension educators where asked to rank the sources and events they frequently use to provide agricultural information to farmers (Figure 4). Overall, more than 50% of the respondents per region ranked field days and fact sheets as the sources they most frequently used. Extension educators working in the area of extension and research also considered seminars and community education events as sources/events they frequently use for outreach to farmers, while the government sector ranked soil and water conservation district and USDA-related events. The agribusiness sector provides information through industry-sponsored, commodity groups/grower association, and/or crop consultant/ certified crop advisor events. Radio/TV, state department of agriculture programs, and programs on bioenergy were the least frequently ranked events.

**Figure 2:** Mean effectiveness of information sources used by extension educators and other outreach personnel to obtain crop-related information measured on a Likert Scale: 1= not effective, 2= somewhat effective, 3= effective, 4= very effective. (Sample size for each region is: Pacific Northwest N = 130; Prairie Gateway N = 433; and Northern Great Plains N = 255)
To learn about extension educators’ awareness of different biofuel feedstocks and bioenergy crops, a series of Likert-scale questions was asked in the survey about their familiarity with these feedstock options and crops. On average, respondents were aware of the use of current agronomic crops, agricultural residues, bioenergy crops, and oilseed crops for producing ethanol and other biofuels. However, according to extension educators, producers have not often asked about feedstock production options (e.g. cellulosic) for their farming operations or for the use of oilseed crops for producing biodiesel and bioenergy in the western U.S.

Using a Likert scale (1= no knowledge to 5= very knowledgeable), extension educators were asked to evaluate their knowledge of concepts that they might need to know when providing feedstocks and biofuel information to farmers. Results are summarized in Figure 5. Showing means higher than 2.6 for all regions, respondents considered themselves to have more knowledge in areas regarding crop production (e.g. planting and harvesting practices; soil fertility, pest control, and irrigation management) and conservation (e.g. residue removal and soil quality impacts; water and environmental conservation). Other topics such as labor and equipment requirements, bioenergy crop yields, crop rotation with bioenergy crops, and cover crops in bioenergy crop rotations had means higher than 2 but lower than 3 (little to some knowledgeable). Extension educators grouped in the extension and research and agribusiness areas affirmed having little knowledge about bioenergy crop yields, and transportation and storage of biomass, while those in the agribusiness group indicated little knowledge about contracting. Overall, it seemed that extension and outreach agents did not have enough information about the economic aspects of feedstock and biofuel production (including contracting) and bioenergy assistance programs.

4 Discussion

Extension and other outreach agents can be a powerful tool in helping to provide information and design programs to help farmers and agribusiness with the development of the bioenergy market industry. To assist with this development it is important to determine appropriate outreach and learning methods, to assess the current state of knowledge, and understand perceptions about bioenergy feedstocks and biofuel markets. Not only do agricultural producers, agribusiness and industry need technical assistance to develop biofuel feedstock markets, but extension and outreach agents must understand the information being disseminated to them from scientists and researchers. Thus, we must understand what is

![Figure 3: Events that extension educators and other outreach personnel ranked in the top three types they will likely attend to obtain crop and other agricultural production-related information. (Sample size for each region is: Pacific Northwest N = 130; Prairie Gateway N = 433; and Northern Great Plains N = 255)](image-url)
the current state-of-knowledge and how do we transfer information successfully from scientists to the end user. In addition, it is important to understand the avenues of communication that are the most successful in transferring this information and knowledge.

The sources or events extension educators primarily prefer to obtain agricultural-related information were Internet, extension websites, newsletters, university extension publications, conferences, meetings, interactive workshops, field days, and on-farm demonstrations. Furthermore, in the particular case of those extension agents working in the extension/research and the government sectors, other sources such as research experiment station publications and federal agricultural agencies were widely used, as well. These results agree with Lakai, et al. [23], who identified effective educational strategies that help extension agents to acquire desired competencies. They found that 74% of the surveyed extension agents prefer face-to-face small group training workshops and only 5% prefer a combination or two or more delivery methods. However, different from finding in this paper, their least preferred delivery methods were electronic and printed learning materials. Lakai, et al. [23] argue that the preference of extension agents for face-to-face small group training workshops offered at a nearby location may help to minimize training costs.

Regarding outreach methods, all the Extension and outreach agents surveyed most frequently delivered information through field days and fact sheets. Seminars and community education events were preferred for educators.

Figure 4: Sources and events that extension educators and other outreach personnel ranked in the top three types they would likely use the most to provide crop related information to farmers. (Sample size for each region is: Pacific Northwest N = 130; Prairie Gateway N = 433; and Northern Great Plains N = 255)
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working in the area of extension and research. Agents working in the government sector preferred soil and water conservation district and USDA related events, while those working in the agribusiness sector used industry-sponsored, commodity groups, grower association, and crop consultant events for outreach to farmers. These findings are similar to those in studies about farmers’ preference for extension delivery methods. Franz, et al. [24] examined the learning methods farmers prefer and compared them with the preferred teaching methods of extension agents and specialists. This study found that farmers’ preferred learning methods were: hands-on, demonstrations, farm visits, field days, discussions, and face-to-face. Farmers showed a mixed preference towards online-methods, newsletters, books/manuals, on-farm tests, meetings, and lectures. Radio was the least preferred method. Radhakrishna, et al. [25] found that longleaf pine landowners in South Carolina preferred newsletters, publications, and field tours. Internet was the least preferred delivery method, which may be due to the significant negative correlation between age and technology delivery systems found in their study. Franz, et al. [24] recommend the use of the internet as a delivery method with farmers who utilize it. Radhakrishna, et al. [25] concluded that there is a need to maintain updating Extension agents on demographic changes and its consequent change in the demand of different delivery methods.

5 Conclusions

This paper assesses extension and outreach education levels about feedstock and biofuel production in the western United States using a survey of extension and outreach agents. The paper contributes to the literature by assessing extension education methods related to feedstock and biofuel production, which has not significantly been examined in the literature to the authors’ knowledge. In addition, survey results provide insight into differences in preferences for learning and teaching across different geographical regions and type of occupation. Results indicate that extension and outreach agents work primarily with farmers and agribusiness groups. Their current preference for learning and outreach methods agrees with other studies on farmers’ preferences about delivery methods. The use of field days, seminars, and community education events are important to maintain networking among farmers and the industry [24]. The use of the internet will depend on the age and technical knowledge.
of clientele and demand will increase as demographic characteristics change. Consequently, it is important to continue to study changes on the preference of delivery methods as technological and agriculture advance.

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