What Influences Awareness of Farmers on Sustainability of Bioenergy Feedstock in the Philippines?

Elena A. Eugenio[a, d ✉], Lilibeth A. Acosta[a, b], Nelson H. Enano Jr.[c], Damasa B. Magcale-Macandog[d], Paula Beatrice M. Macandog[d], Joan Pauline P. Talubo[e], Arnold R. Salvacion[e], and Jemimah Mae A. Eugenio[f]

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ABSTRACT The paper presents an analysis of bioenergy potential in the Philippines by understanding farmers' awareness on sustainable bioenergy production using different feedstock, i.e. first generation (i.e. sugar-rich crops, starch-rich crops and oil-rich crops) and second generation (i.e. agriculture/forest residues, fast-growing trees, and perennial grasses). Such an assessment is critical for many developing countries including the Philippines due to the impact on food security, particularly as a result of the negative effects of bioenergy feedstock production and processing on increasing water scarcity and agricultural land pressure. Moreover, farmers play a key role in the production of biomass feedstock for bioenergy, so it is important to understand their level of awareness on the effects of bioenergy not only on food security but also economy as a whole. Field survey was conducted with farmers in three regions including Calabarzon, Central Visayas and Davao. The paper presents the results of the factor and cluster analyses, which were applied to determine the socio-economic profiles that characterise the opinions of the farmers. The survey results showed that the diversity of awareness across regions is influenced not only by the socio-economic characteristics of the farmers but also sources of information about bioenergy.

a School of Environmental Science and Management, University of the Philippines in Los Baños, Philippines

b Potsdam Institute for Climate Impact Research, Telegraphenberg, 14473 Potsdam, Germany

c Department of Community and Environmental Resource Planning, College of Human Ecology, University of the Philippines in Los Banos, Philippines

d Tropical Institute for Climate Studies and Center for Renewable Energy and Alternative Technologies, Ateneo de Davao University, Philippines

e Institute of Biological Sciences, College of Arts and Sciences, University of the Philippines in Los Banos, Philippines

f Institute of Mathematical Sciences and Physics, College of Arts and Sciences, University of the Philippines in Los Baños, Philippines

✉ Corresponding author. Email: lena.eugenio18@gmail.com,

Tel: +63-49-5016503.

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1. Introduction

Bioenergy is carbon neutral renewable energy, which is considered as source of energy for sustainable development. Although the production and consumption of biofuels like biodiesel and bioethanol have become important policy priorities, sustainable bioenergy production needs to be ensured by using suitable feedstock resources. Due to unstable and increasing energy prices as well as increasing global energy demand, many countries has perceived bioenergy as an attractive alternative or addition to meeting their current and future energy needs (UNESCAP, 2008). Interest in liquid biofuels production and consumption has increased worldwide as part of government policies to address the growing scarcity of fossil fuels and, at least in theory, to help mitigate adverse global climate change. Like many other countries, the Philippines is implementing various bioenergy policies to reduce its dependence on imported oil, enhance economic growth, contribute to climate change mitigation and promote rural development (Acosta et al., 2013). The Philippines has a large potential in producing bioenergy because crops that are used as feedstocks for the production of bioenergy are indigenous or locally grown (i.e. traditional) in the country. Biofuels will give the otherwise traditional crops a boost towards value added processing. It will encourage investments, create jobs, and increase farmgate prices. In the Philippines, production of biodiesel mainly uses domestic raw materials from coconut and bioethanol is mainly produced from sugarcane. Other feedstocks under consideration by the Philippine government are jatropha, sweet sorghum, cassava and corn.

According to Department of Energy (DOE, 2010), domestic fuel industries in the Philippines produced 132.99 million litres of biodiesel and 4.14 million litres of bioethanol in 2011. These industries have much higher capacities (i.e. 393 and 133 million litres biodiesel and bioethanol, respectively), hence the country has more potential to produce biofuels domestically (Corpuz, 2013; DOE, 2010). However, since 2007, the Philippines have been importing bioethanol to meet the mandated level of 10% blending of bioethanol. In 2013, bioethanol imports were as high as 248 million litres, which is about 83% of the required bioethanol blending by the government. The main reasons

given for the dependence on bioethanol imports despite the available capacity for domestic production are the inadequate capacity of existing sugarcane distilleries, low productivity, and high production costs, which erode the competitiveness of locally grown sugarcane (Corpuz, 2013).

A recent empirical study by Acosta et al. (2013) revealed that an important barrier to the sustainability of bioenergy production in the Philippines is the lack of awareness among farmers, who play a key role as producers of feedstocks. The authors developed cluster typologies (i.e. idealist, ambivalent, realist) based on their perceptions and opinions on bioenergy. The focus of their analysis was however not only the farmers but also respondents from the academe, private companies and public institutions in selected case study areas in Luzon and Mindanao. Moreover, other available studies in the Philippines and other countries mostly focused on the willingness of farmers to cultivate bioenergy crops (e.g. Convery, Robson, Ottitsch, & Long, 2012; Caldas et al., 2014; Zyadin et al., 2015). The issue of awareness, which influences farmers' willingness to produce bioenergy, has received only little attention in other countries (e.g. Halder et al., 2013; Gautam, Pelkonen, & Halder, 2013), and has been so far overlooked in the Philippines. But environmental awareness is important in changing the behaviour towards bioenergy (Maras, Moon, Gridley, Hayes, & Key, 2015; Streimikiene, 2015).

This paper aims to contribute to the above-mentioned research gap and substantiate the findings on the lack of awareness of famers on bioenergy by (1) focusing the analysis only on farmers; (2) expanding the case study areas to cover Visayas, the largest producer of sugarcane for bioethanol; and (3) developing typologies on the level of farmers' awareness. In this paper, we also analysed the preferred crops by the farmers for the production of bioenergy and their knowledge on the impacts of bioenergy on food security and economic growth. Thus, the study assumes that sustainability of bioenergy production (i.e. feedstock will be produced for bioenergy and its production will be sustained in the future) depends on farmers' awareness on the social and economic impacts of alternative bioenergy feedstock. Given this assumption, the relevant questions that guided the study include: (1) Are farmers aware of the diverse feedstock resources for bioenergy? and, (2) what factors influence the level of awareness across different regions? The paper is structured as follows: section 1 describes the development of bioenergy in the Philippines; section 2 discusses the methods used to collect and analyse the survey data; section 3 presents the results of the factor and cluster analyses; and section 4 provides conclusion.

2. Methodology

2.1. Case Study Areas

The study was conducted in three regions that are currently major producers of coconut and sugarcane in the three main islands in the Philippines, i.e. Calabarzon in Luzon, Central Visayas in Visayas and Davao in Mindanao (Figure 1). Calabarzon is designated as Region IV-A and has five adjoining provinces in southern Tagalog region, i.e. Cavite, Laguna, Batangas, Rizal and Quezon. Central Visayas is designated as Region VII and composed of four island provinces including Negros Oriental, Cebu, Bohol and Siquijor. Davao region is designated as Region XI, consisting of four provinces: Compostela Valley, Davao del Norte, Davao Oriental and Davao del Sur. Calabarzon has large monoculture coconut plantations and large forest of various trees. Central Visayas has large arable land with cereals and sugar, while Davao has large diversified coconut plantations. Both regions have large cultivated areas with grass. Climate is relatively variable in the three regions due to their geographical locations.

Calabarzon region has a total land area of 1,622,861 hectares, which comprise 5% of the Philippine Archipelago and is the most populated region of the country with a population of 12,609,803 (Table 1). During the period 1971–2000, the measured average annual rainfall is 4,150.1 millimetres (BAS, 2011, CropsReview, 2011). The study sites for conducting survey

Characteristics	Calabarzon	Central Visayas	Davao
Population in 2010 Growth from 2000	12,609,803 3.07%	6,800,180 1.77%	4.468.563 1.97%
GRDP million PhP Share of agriculture to GRDP	1,030,165 6.25%	36,638 7.81%	224.849 18.87%
Agricultural land area Share of agriculture to total area	588,516 35.0%	522,433 33.0%	758335 37.0%
Agricultural employment Share of agriculture to total employment	742,000 16.0%	905,000 31.0%	746000 41.0%
Daily agricultural wage Poverty incidence	269.00 10.3%	173,76 30.2%	182.03 25.6%

GRDP = Gross Regional Domestic Product at constant 2000 prices
Source: National Statistics Office (NSO), 2010

TABLE 1. Description of social-economic and biophysical characteristics in the case study regions.

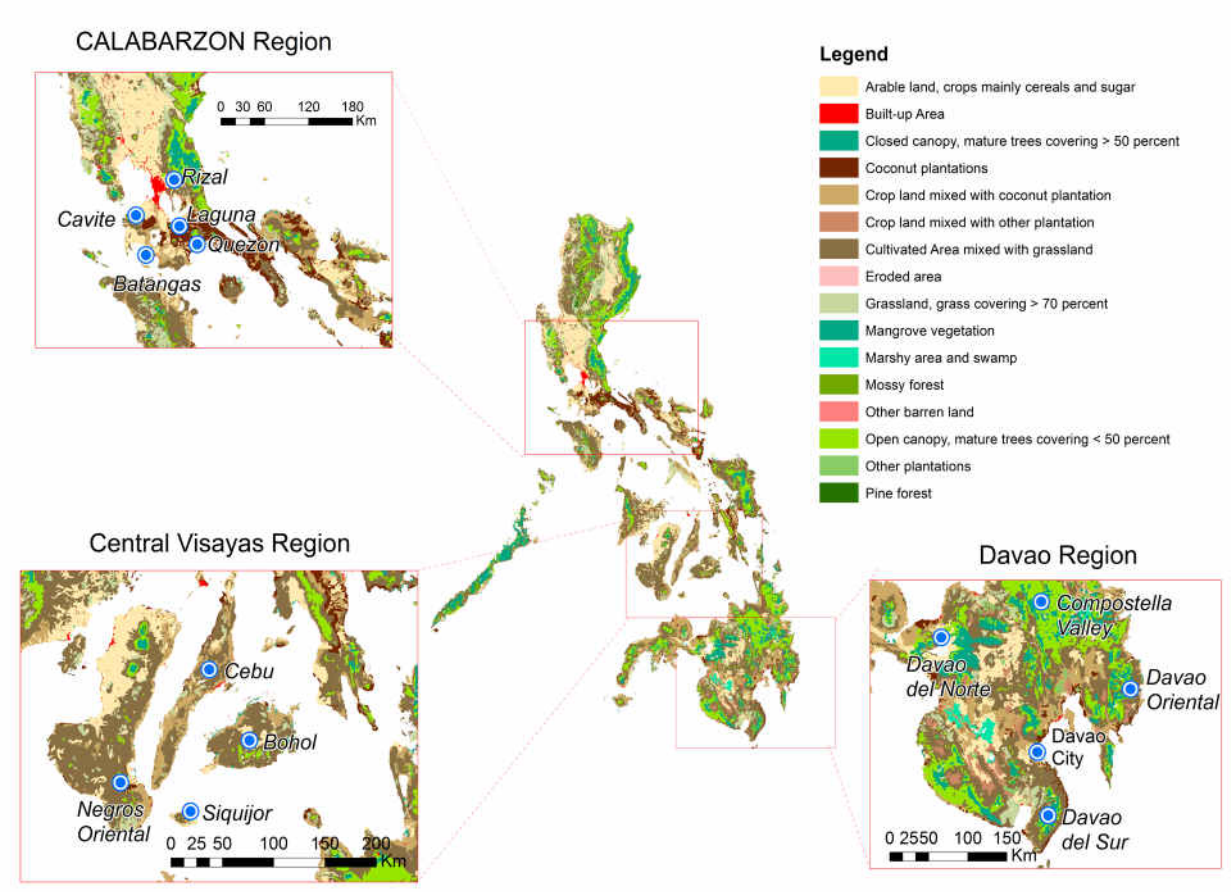


FIGURE 1. Philippine map showing the location of the different case study regions.

in Calabarzon are Infanta, Quezon and Batangas. ***Central Visayas*** region lies at the centre of the Philippine archipelago between the two main islands of Luzon and Mindanao. It is the sixth smallest region in the country with a total land area of 1.58 million hectares. The population is also relatively small at 6,800,180. The climate of the region is tropical-monsoonal. The survey in Central Visayas region was conducted in Bohol and Cebu. With the exception of Bohol, the topography of Central Visayas is rugged and is characterised by highlands dominating the interior of the provinces, with narrow strips of arable land lining the coast. Davao region is located on the south-eastern portion of Mindanao with a total land area of 2,035,742 hectares and has a population of 4,468,563. Agriculture is the main economic activity in the region and banana is the primary agricultural product. While the region's economy is predominantly agriculture-based, it is now developing into a centre for agro-industrial business, trade and tourism. Aside from its forestland and fertile fields, the region is famous for its rich mineral resources. The study sites for the survey in Davao region were mainly Davao City and Davao del Norte.

2.2. Data Collection and Analyses

Household surveys were conducted with 234 farmers in the case study regions (i.e. 112 in Calabarzon, 60 in Central Visayas, and 58 in Davao) in 2013. More farmers were surveyed in Calabarzon where the population is twice as large as in the other regions (Table 1). The surveys were conducted by the authors, who consulted the local government officials to get permission for the survey and information on the locations of the farmers. We selected farmers who are producing major feedstock for bioenergy in the Philippines like coconut, sugarcane, corn, rice (for agricultural residues), etc. The questionnaire was constructed based on four types of information on (1) socio-economic characteristics, (2) sources of information on bioenergy, (3) knowledge and opinion on bioenergy, and (4) preferences on bioenergy feedstock. Socio-economic characteristics include gender, age, education, and locations of domicile and work. Sources of information on bioenergy identify the level of importance for the media (television, newspaper), internet, family and friends, work colleagues, neighbours, public officials, academe/science, and business partners. Knowledge and opinion on bioenergy are answers to the following questions: *(i) Are you familiar with the term "bioenergy" (also known as biofuels)? (ii) Is your work related to bioenergy? (iii) In your opinion, is bioenergy good or bad for your country? (iv) Do you think the use of biomass from food crops for bioenergy production increases food prices and thus affects food security (i.e. food affordability and availability) in your country?* Preferences on bioenergy feedstock provide rating (i.e., very low, low, high, very high, and do not know) on the potential contribution of the food crops (and non-food) for the sustainable production of first (and second) generation bioenergy.

We applied factor analysis, in particular principle component to identify the most important variables across all four

types of information, i.e. those with largest contribution to the variance (i.e. difference or spread) in farmers' responses to the survey questions. Only the most important variables were used as input variables to the cluster analysis, which followed a two-step approach—hierarchical and K-means clustering. In this paper, cluster analysis aimed to categorise farmers into clusters and determine the appropriate number of clusters, so that farmers within a cluster have common characteristics and farmers in different clusters have diverse characteristics. The results of the analysis were used to develop typology on farmers' awareness on bioenergy. The SPSS software was used for the factor and cluster analyses. More details on the methods applied in this study are available in Eugenio et al. (2016) and textbooks on data mining (e.g. Tan, Steinbach, & Kumar, 2005).

3. Results and Discussions

3.1. Factors and Their Regional Variation

Table 2 compares the different case study regions according to the most important variables identified from the factor analysis. Most farmers in Central Visayas are still very young, highly educated and mostly live in urban/sub-urban area. Farmers in Calabarzon are in their retirement age and live in rural areas, while farmers in Davao are in their middle and retirement age, and mostly living in rural areas. A large number of famers in Central Visayas consider many sources of information on bioenergy as important (Table 3). The source of information that is important for the farmers in the three regions is media (TV, newspaper). Internet is the least important source of information because most of the farmers live in farms where internet is not very accessible. Only media is considered most important by half of the surveyed famers in Davao. Perceptions on potential sources of bioenergy feedstock, for both first and second generation, tend to be similar across all three case study regions, i.e. high potential level, except for Calabarzon. Farmers in this region consider perennial grasses to have low potential as source of feedstock. Experts suggest however that second generation bioenergy feedstock (e.g. grasses) is more sustainable because they do not use food crops and thus not affect food security. Moreover, they can be planted in marginal areas or less productive land.

Familiarity with bioenergy or biofuels is highest in Davao and lowest in Calabarzon (Table 3). However, work of farmers in Calabarzon is more related to bioenergy compared to Davao and Central Visayas. As for their perception on the impact of bioenergy on the economy, all or almost all farmers in the three regions consider bioenergy as useful. But they also think that it affects food security when biomasses from food crops are

Factors	Calabarzon	Central Visayas	Davao
Age			
< 30	6.03	37.93	11.67
31-40	16.38	44.83	20.00
41-50	12.93	6.90	31.67
51-60	33.62	10.34	26.67
> 60	31.03	0.00	10.00
Gender			
Male	50.86	51.72	58.33
Female	49.14	48.28	41.67
Domicile			
Urban/sub-urban	4.31	55.17	10.00
Mountain/forest	12.93	0.00	0.00
Farm/agriculture area	68.10	44.83	86.67
Riverside/coastal area	11.21	0.00	0.00
Education			
Primary/Grade School	25.86	17.24	43.33
Secondary	50.86	27.59	31.67
Undergraduate (Bachelor)	14.66	43.10	20.00
Graduate (Master/Doctor)	1.72	12.07	5.00

Note: The values represent the percentage of farmers for each factor category (i.e. age, gender, domicile, and education) and sum up to 100% for each region.

TABLE 2. Regional comparisons of socio-economic characteristics, in percent.

Category	Calabarzon	Central Visayas	Davao
Source of information			
Work colleagues	45.69	65.52	41.67
Family & friends	47.41	63.79	45.00
Academe/science	55.17	56.90	36.67
Public officials	55.17	56.90	45.00
Neighbours	31.03	67.24	41.67
Media (TV, Newspaper)	56.90	75.86	51.67
Business partners	23.28	56.90	41.67
Internet	18.97	39.66	35.00
High potential for production			
Sugar-rich crops	52.59	100.00	85.00
Perennial grasses	42.24	96.55	85.00
Starch-rich crops	58.62	100.00	85.00
Fast growing trees	52.59	96.55	85.00
Oil-rich crops	74.14	98.28	85.00
Agriculture/forest residues	58.62	100.00	85.00
Energy source- Bioenergy			
Low	5.17	1.72	10.00
Medium	20.68	12.07	5.00
High	39.66	50.00	30.00
Very high	28.43	36.21	41.67
Do not know	6.03	0.00	13.33
Knowledge on bioenergy			
Familiar with bioenergy	43.10	55.17	68.33
Work related to bioenergy	30.17	0.00	5.00
Food security	57.76	87.93	63.33
Bioenergy is good for economy	98.28	100.00	100.00
Work Region	49.57	24.79	25.64

Note: The values represent the percent of farmers who have chosen or answered "yes" for the item/question in each category. For example, 45.69% of the farmers in Calabarzon answered that work colleagues are sources of their information on bioenergy.

TABLE 3. Regional comparisons on the knowledge and sources of information on bioenergy, in percent.

used for bioenergy production. The number of farmers who think that there is a link between bioenergy and food security is largest in Central Visayas. Farmers in the three regions also assessed the potential contribution of bioenergy in comparison with other energy sources (i.e. renewable energy and fossil fuel) in promoting economic growth in the country. Central Visayas gave the highest potential for bioenergy and Davao the lowest relative to other renewable resources. Most of the surveyed farmers were male, except for Calabarzon where the gender of farmers is almost equally distributed (Table 2). Female should have knowledge or awareness on bioenergy because they take part in farming decisions and are also part of country's economic growth or development.

3.2 Clusters and Their Typologies

Four clusters of farmers were identified from the cluster analysis. Based on the responses of the farmers in each cluster on the survey questions, we analysed the profiles of the clusters to give some indications on the typologies based on the level of awareness. These typologies, which we describe as unaware, low awareness, moderate awareness and high awareness, are as follows:

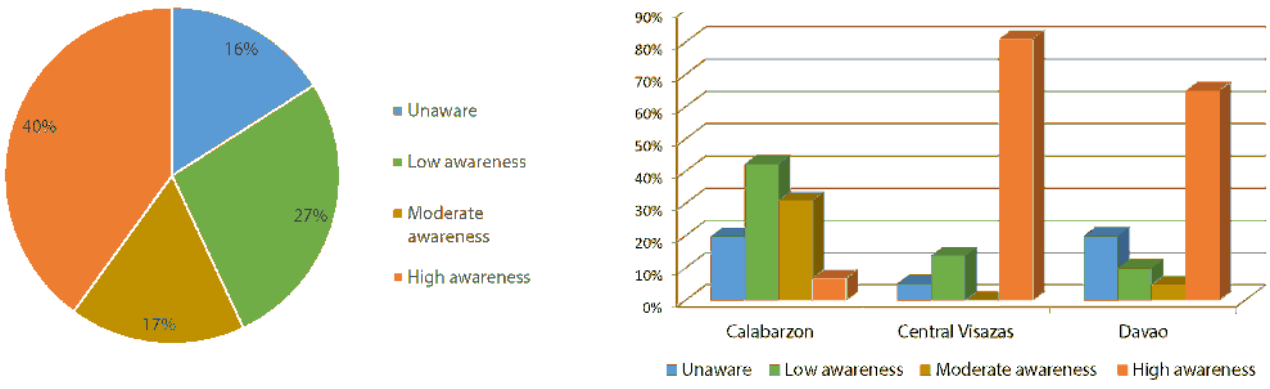
consists of farmers whose age is near to retire, residence is mainly rural area and most important sources of information on bioenergy are other farmers. They think oil-rich crops have high potential contribution for the sustainable production of bioenergy. They have low familiarity with bioenergy and consider their work as not related to bioenergy. On the other hand, they believe that bioenergy does not affect food security but they are not sure if bioenergy can contribute to economic growth. The level of awareness of farmers in this cluster can be considered extremely low and can thus be characterised as "unaware".

- **Cluster 2** consists of farmers who are middle aged, live in rural areas and highly educated. Media (e.g. television and newspaper) and internet are relatively important sources of information by the farmers in this cluster. They consider feedstock from non-food crops such as perennial grasses, agriculture and forest residues to have very high potential contribution to sustainable bioenergy production. The largest proportion of farmers who think the potential for these non-food crops is high or very high belongs to this cluster. They are very familiar with bioenergy although their work is not related to it. They believe that bioenergy will affect food security, but nonetheless it has very high potential to support economic growth. As compared to the farmers in other clusters, those in this cluster can be considered very informed and thus have a typology of "high awareness".
- **Cluster 3** consists of farmers whose age is close to retirement, residence is in rural areas, and most important sources of information are family and friends. They consider only oil-rich crops to have high potential as feedstock for bioenergy production. They are not familiar with and consider their work as not related to bioenergy. Famers in this cluster have thus very close characteristics with those in cluster 1. However, in contrast to cluster 1 farmers, they believe that bioenergy has high potential for the economy, but at the same time it will affect food security. These farmers can thus be considered to have a typology of "low awareness".
- **Cluster 4** consists of farmers who are in retirement age and already retired, educated, and live in rural areas. The neighbours are relatively important source of information for the farmers in this cluster. They consider fast-growing trees to have average potential as feedstock for bioenergy. They are most familiar with bioenergy and largely think that their work is related to bioenergy. Moreover, they consider bioenergy to have average potential for economic growth. Regarding food security, opinion of farmers in this cluster are rather mixed, with half of the farmers thinking bioenergy will affect food security and the other half is of opposite opinion. The level of awareness of the farmers can thus be considered moderate or typology corresponding to "moderate awareness".

Figure 2 shows how the farmers are distributed among the four typologies. The largest number of farmers has a typology of high awareness (40%), followed by low awareness (Figure 2a). Farmers with high awareness are found predominantly in Central Visayas, followed by Davao (Figure 2b). Few farmers are unaware in Central Visayas. Davao has the least number of farmers who has low awareness. Calabarzon is where the greatest number of farmers who have low and moderate awareness. Farmers who are unaware or have extremely low level of awareness are almost equally distributed in Calabarzon and Davao.

4. Conclusion

This study presented the analysis of awareness of farmers on sustainability of alternative bioenergy feedstock. The results showed that there is variation on farmer's awareness¬¬ in the case study regions in the Philippines. Central Visayas has the greatest number of farmers with high awareness typology, while Calabarzon has the least number of farmers with this typology. Farmers with high awareness is largest in Central Visayas because many farmers are still in their young age, age that still have the time and interest to explore or learn new ideas; highly educated, where they have supplementary knowledge from their schools/universities; and mostly reside in urban area where information reaches farmers ahead of time. In contrast, many farmers in Calabarzon and Davao mostly reside in rural areas and in their retirement age or already retired. These characteristics make them rather indifferent to the issues



a) b)

FIGURE 2. Distribution of farmers by (a) typology and (b) region.

of bioenergy and should be taken into account in designing strategies to build their awareness.

In addition to the socio-economic factors, sources of information have significant effect on farmer's knowledge on bioenergy. The most important sources of information by the farmers with high awareness in Central Visayas are media and internet. Farmers in this typology, although their work is not related to bioenergy, consider non-food crops to have potential to contribute to the sustainability of bioenergy production. Farmers should have an understanding on this issue in view of the fact that they are in the primary sector that is involved in supporting production of bioenergy feedstock. Considering the low level of awareness of the farmers in the two other regions (i.e. Calabarzon and Davao) particularly among female respondents, it is important to provide them the necessary information and training. Farmers should be well informed on the sustainability of feedstock for first and second generation to ensure that bioenergy promotes rural development and does not cause food insecurity. The Philippine government's current blending targets of 10% for bioethanol and 5% for biodiesel are planned to be increased to 20% in year 2025 (Corpuz, 2013). To achieve these targets, policy should not focus on meeting the targets by importing biofuels but by encouraging farmers to produce the required feedstock. This will require capacity building programmes that enhance and spread awareness among the farmers.

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