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Typology of Farmers' Awareness on Sustainability of Alternative Bioenergy Feedstocks in the Philippines

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Abstract

The paper presents an analysis of bioenergy potential in the Philippines by understanding farmers' perceptions on sustainable bioenergy production. It focuses on the opinions of farmers for both 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) bioenergy crops, which are being or can be used for the production of biodiesel and bioethanol. Such an assessment is critical for many developing countries including the Philippines due to its 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 on food security and economy. Field survey was conducted with farmers in three regions including Calabarzon, Central Visayas and Davao. The paper presents the results of the cluster analysis, which was applied to determine the socio-economic profiles that characterize the opinions of the farmers. The survey results showed that there are differences in the level of awareness of the farmers in the different regions in the Philippines and these were categorized into four typologies, such as unaware, less awareness, moderate awareness and high awareness. Farmers with unaware typology were located in Calabarzon and Davao, large number of farmer with low to moderate awareness were found in Calabarzon and farmers with high awareness were located in Central Visayas.

Keywords: Bioenergy, biofuels, cluster analysis, first and second generation bioenergy, food security, Philippines

1. Introduction

The global production and consumption of biofuels have increased dramatically in the past few years, primarily due to intensifying concerns about national energy security, increasing oil prices, environmental considerations (i.e. climate change mitigation), and efforts to revitalize rural communities. The question today is not whether biofuels will be a part of the energy mix, but rather what economic, social, and environmental implications they will have [2, 34].

Biofuels or bioenergy are renewable energy and carbon neutral so that they are considered sustainable. As is generally known, there are two kinds of biofuels- biodiesel and bioethanol. Biodiesel is a fuel extracted typically from oils of coconut and oil palm. It is a natural hydrocarbon with little sulfur content, and can be used in diesel engines with very little or without any need for engine modification. Bioethanol, on the other hand, is a form of ethanol, a light alcohol, produced by fermenting carbohydrates, such as starch or sugar, in vegetable matter. Sources of bioethanol being explored are corn, sugarcane, cassava, and sweet sorghum [18, 25].

Due to unstable and increasing energy prices as well as increasing worldwide energy demand, many countries has perceived bioenergy as an attractive alternative or addition to meet their current and future energy needs [22]. 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. The existing biofuels markets are dominated by U.S. ethanol production based on cornstarch (34,069 M liters/year), Brazilian ethanol production (24,500 M liters/year) based on sugarcane, and European biodiesel production (e.g..Germany with 2,819 and France with 1,972 in thousands of tonnes/year) based on rapeseed oil [24, 31].

Like in many other countries, the Philippines is implementing various bioenergy policies to reduce dependence on imported oil, enhance economic growth, contribute to climate change mitigation and promote rural development [1]. 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. Other benefits that can be achieved by growing traditional crops as bioenergy is that, increase utilization of agricultural land, promote investment, and create jobs. Biofuels will give the otherwise traditional crops a boost towards value added processing. It will encourage investments, create jobs, and increase farmgate prices although production should be established. In the Philippines, production of biodiesel mainly uses domestic raw materials from coconut and bioethanol is mainly produced from sugarcanes. Other feedstocks under consideration by the Philippine government are jathropa, sweet sorghum, cassava and corn. However, corn as a biofuel feedstock has issues and threats on the supply of feeds for livestock. Currently, the Department of Agriculture (DA) is focused in using sugarcane as feedstock and the use of other crops like sweet sorghum and cassava remains in the R&D stage [14].

According to Department of Energy (DOE), domestic fuel industries in the Philippines produced 132.99 million liters of biodiesel and 4.14 million liters of bioethanol in 2011. These industries have much higher capacities (i.e. 393 and 133 million liters biodiesel and bioethanol, respectively) hence the country has more potential to produce biofuels domestically [10, 16]. However, since 2007, the Philippines have been importing bioethanol to meet the mandated level of 10% blending of bioethanol. In 2013 the bioethanol imports were as high as 248 million liters, 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 due to inadequate capacity of existing sugarcane distilleries, low productivity, and high production costs erode the competitiveness of locally grown sugarcane [10].

Recent empirical study by Acosta et al. [1] revealed that an important barrier to the sustainability of bioenergy production in the Philippines is the lack of awareness among the farmers, who play key role as producers of feedstocks. They 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 in Mindanao. This paper aims to substantiate the findings on the lack of awareness of famers on bioenergy by (1) focusing analysis only on farmers; (2) expanding the case study areas to cover Visayas, largest producer of sugarcane for bioethanol; and (3) developing typologies on the level of farmers' awareness. In this paper, we also analyze 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. 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 conclusions.

2. Philippine bioenergy development

The growing focus towards a cleaner and greener environment has directed the Philippine government to search for more alternative renewable sources of fuel and energy. With the recent enactment into law of the RA 9367 otherwise known as the Biofuels Act of 2006 last January 12, 2007, the mandatory use of biofuels shall be enforced in support to the government's goal in reducing dependence on imported fuels with due regard to the protection of public health, the environment and natural [14]. The DOE likewise promulgated the Implementing Rules and Regulations (IRR) in 17 May 2007. The Biofuels Act is formally entitled "An act to direct the use of biofuels establishing for this purpose the biofuels program, appropriating funds therefore, and for other purposes." The IRR covers the "production, blending, storage, handling, transportation, distribution, use, and sale of biofuels, biofuel-blends, and biofuel feedstock in the Philippines" [15, 22].

According to the DA, the objectives of Biofuels Act are as follows: (1) developing and utilizing indigenous renewable and sustainably-sourced clean energy sources to reduce dependence on imported oil; (2) mitigating toxic and greenhouse gas (GHG) emissions; (3) increasing rural employment and income; and (4) ensuring the availability of alternative and renewable clean energy without the detriment to the natural ecosystem, biodiversity and food reserves of the country [1, 5, 14, 15, 17]. The Biofuels Act also provides an incentive of a zero-rated specific tax on the biofuels component of blended gasoline or diesel. Other incentives include an exemption from value-added tax for the sale of raw materials in the production of biofuels, exemption from wastewater charges under the Clean Water Act, and the extension of financial assistance from government financial institutions for the production, storage, handling, and blending of biofuels [9].

To support and comply with the provisions of the Biofuels Act, the DA has been pursuing the Biofuel Feedstock Program, which provides (1) production support services, (2) extension support, education and training services, (3) credit facilitation, (4) research and development, (5) irrigation support services, other infrastructure and postharvest & development services, and (6) marketing development to promote the use of coconut and jathropa for biodiesel and sugarcane, cassava, and sweet sorghum for bioethanol [1].

The biofuel Acts emphasized the use of coconut as the major feedstock for biodiesel production. Its product Coconut Methyl Ester (CME), derived from coconut oil (CNO), possesses characteristics of superior quality and of competitive standards. Biodiesel is the name given to these esters when they are intended for use as transportation fuel [2]. The

Philippines success in biodiesel is primarily due to its being the world's top coconut oil (CNO) producer [9, 10]. Out of the 79 provinces which comprise the country, 68 provinces produce coconuts. The total land area planted to coconut is 3.5 million hectares, in which Luzon covers 1.14 M ha, Visayas with 0.67 M has and Mindanao with 1.76 M has, about 25% of the agricultural lands, thus, more than 344 million nut-bearing trees were planted in the country, where Luzon has 105.50 M trees, Visayas has 68.76 M trees and Mindanao has 170.11 M trees, which produces more than 15.86 M metric tons for the 3 regions, where 3.18 M metric tons, 2.70 M metric tons and 9.44 M metric tons, respectively [4]. About one-third of the country's population depends directly or indirectly on the coconut industry as a source of income and a means of employment and livelihood, employing 2.6 million farmers and 1.9 million farm workers [14]. Developing coconut industry for sustainable biodiesel production will thus have great impact on rural development.

While palm oil is now the main feedstock for producing biodiesel in Malaysia and Indonesia [31], there are only few pilot plantations growing oil palm in the Philippines. The government also supports the cultivation of jatropha, a second generation bioenergy crop, for the production of biodiesel. According to Acosta et al. (2013) the Philippines thus have the potential to develop a sustainable bioenergy sector using bioenergy crops that does not compete with food crops and agricultural lands. In the past years, the government has launched massive propagation and cultivation of jathropa seeds covering around 2 million hectares of unproductive, marginal and idle public and private lands all over the country. This effort was aimed to produce about 5,600 million liters of biofuel in the next 10 to 12 years [2, 9]. Jathropa can be planted in any soil types, even in marginal lands, and grows well under tropical and subtropical climate and is found throughout the country [18, 20, 29]. The jathropa cultivation was however encouraged also in productive lands, thus encouraging farmers to shift cultivation from other food crops. Moreover, farmers were not able to sell their jathropa harvest due to lack of awareness about its market.

The National Biofuels Program recognizes the vital role of the sugarcane industry as the major supplier of feedstock for the production of bioethanol. The sugar industry is currently producing more than 10% surplus sugar that could very well supply a good portion of the country's initial needs for bioethanol. Sugarcane provides the highest yield of ethanol per hectare compared to other crops (with the possible exception of sweet sorghum, the worth as feedstock of which remains to be proven locally). Nonetheless, sweet sorghum and cassava are additional ethanol feedstocks considered by the government for increasing future bioethanol production [2]. According to Sugar Regulatory Administration (2008), sugarcane industry will have to grow from the 398,872 hectare cropped for sugar on year 2007-08, which is about 18% in excess of the area needed for domestic sugar self-sufficiency, to an aggregate hectare that will supply feedstock for both sugar and bioethanol starting crop year 2008-09 as needed, without affecting sugar self-sufficiency. Sugarcane farmers in the Philippines are approximately 58,996 and around 5 million people are employed in the industry and other sugar-related activities [28].

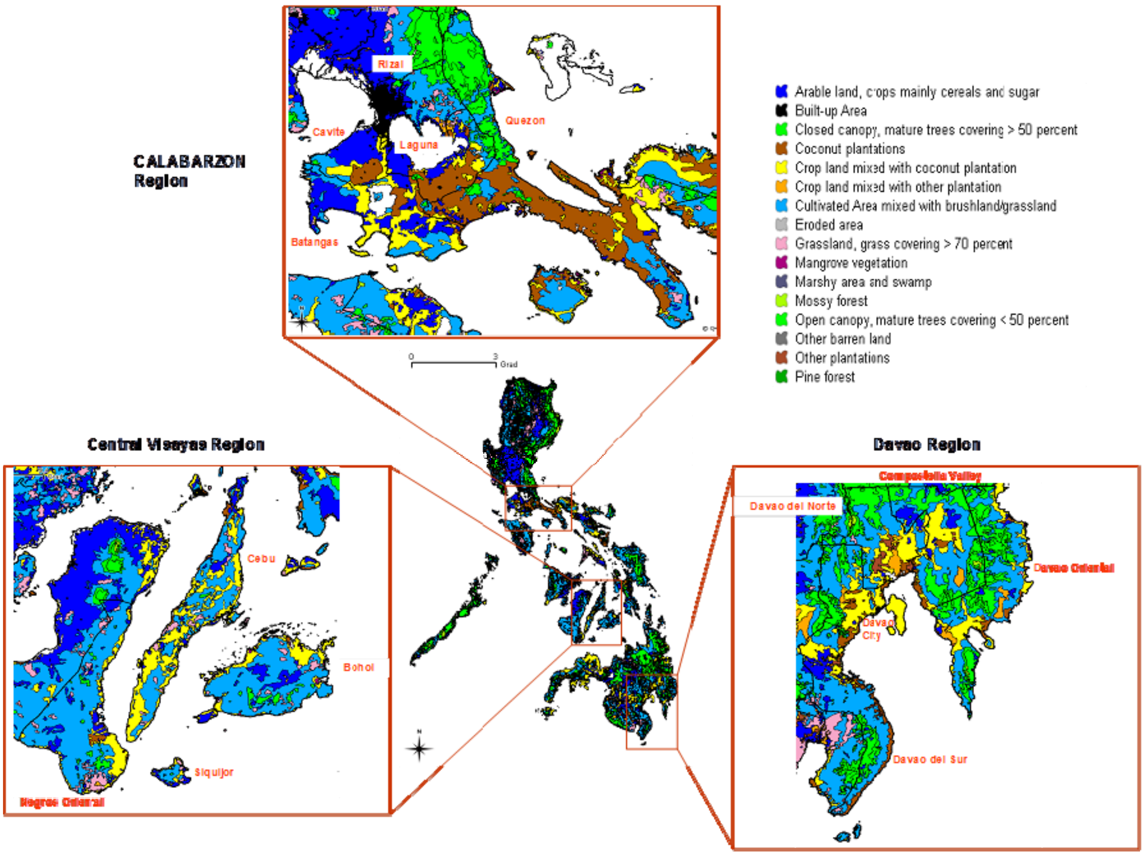
The government considers it as the most reliable feedstock due to its well-established farming technologies and the highest yield per hectare compared to other feedstock (corn, cassava, and sweet sorghum). The Sugar Regulatory Administration (SRA) already identified 237,748 hectares of new sugar fields, mostly in Mindanao, that can be tapped to produce fuel ethanol [2]. At present, however, bioethanol sector is confronted by many structural problems and competition with sugar production resulting to large bioethanol imports.

3. Methods

3.1 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, designated as Region IV-A and has 5 adjoining provinces in southern Tagalog region region including 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 including Compostela Valley, Davao del Norte, Davao Oriental and Davao del Sur. Calabarzon has large monoculture coconut plantations, large forest of various trees. Central Visayas has large arable land with cereals and sugar, large cultivated area with grass, whereas, Davao has large diversified coconut plantations, large cultivated area with grass. Climate is relatively variable in the different regions. There are generally four climates types in the country – Type I, II, III and IV. Type I has two pronounced seasons, dry from November to April, and wet during the rest of the year. Maximum rain period is from June to September. Type II has no dry season but has a pronounced maximum rain period from December to February. There is not a single dry month. Minimum monthly rainfall occurs during the period from March to May. Type III has no very pronounced maximum rain period, with a short dry season lasting only from one to three months, either during the period from December to February or from March to May. This climate type resembles type I since it has a short dry season. Type IV, rainfall is more or less evenly distributed throughout the year. This climate type resembles the second type more closely since it has no dry season. We describe the main differences not only in biophysical but also socioeconomic features in the three case study regions [12, 21].

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



CALABARZON

CALABARZON has a total land area of 1,622,861 hectares which comprise 5% of the Philippine Archipelago and the most populated region of the country with population of 12,609,803 (Table 1). The four climate types are represented in this region. From the period 1971 - 2000 the measured average annual rainfall is 4,150.1 millimeters. [4, 6, 12, 21, 27].

The study sites for conducting survey in CALABARZON are in Infanta, Quezon and Batangas. Infanta, Quezon is a first class municipality in the province of Quezon, has a population of 648,181 (2010 census), situated at the northern part of Quezon province. The town has a total land area of 34,276 hectares. Half of the residents of Infanta rely on tertiary types of economic activity such as wholesale and retail, transportation, storage and communication, finance, insurance, real estate and business service, community, social and personal services. The other half earns through primary and secondary types of livelihood. Twenty-eight percent of the residents are still practicing agriculture, hunting and forestry and fishing, while 22% have ventured into mining and quarrying, manufacturing, electricity, gas and water and construction. Batangas is a first class province located on the southwestern part of Luzon with a total land area of 316,581 hectares and have a population of 2,377,395 [27]. Batangas is a combination of plains and mountains, as well as the world's smallest volcano, Mt. Taal, with an elevation of 600 meters, located in the middle of the Taal Lake. Other well-known peaks are Mt. Makulot with an elevation of 830 m, Mt. Talamitan with 700 m, Mt. Pico de Loro with 664 m, Mt. Batulao with 811 m, Mt. Manabo with 830 m, and Mt. Daguldol with 672 m. Batangas also has many islands, including Tingloy, Verde Island (Isla Verde), Fortune Island of Nasugbu. The Municipality of Nasugbu is the home of the plantation of Central Azucarera Don Pedro, the Philippines' largest producer of sugar and other sugarcane products. Batangueños are indeed fond of drinking. This is of no surprise since it lies in what is called the coconut belt that is the raw material for the local liqueurs, the “lambanog” with 90% proof alcohol and the “tuba” which is made of 5.68% alcohol and 13% sugar [3].

Table 1 Description of social-economic and biophysical characteristics in case study areas

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 agric. to GRDP)	1,030,165	6.25%	36,638	7.81%	224.849	18.87%
Agric. land area (Share to total area)	588,516	35.0%	522,433	33.0%	758335	37.0%
Agric. employment (Share to total employment)	742,000	16.0%	905,000	31.0%	746000	41.0%
Daily agric. wage (Poverty incidence)	269.00	10.3%	173,76	30.2%	182.03	25.6%

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

Central Visayas

Central Visayas Region lies at the center 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 (Table 1). The region has Type II climate classification [4, 26]. The climate of the region is tropical-monsoonal. The tropical condition can be attributed to the location of Region VII which is about 100 to 110 north of the equator. The monsoonal condition, on the other hand, refers to two seasonal wind regimes, the northeasterly winds and the southwesterly winds. The mean annual temperature in the region is 27 ^{0}C, hottest months are February, March and April and the coldest month is January. Due to high temperature and the surrounding bodies of water, the region, as in the case of the Philippines as a whole, has a high relative humidity with mean of 82%.

With the exception of Bohol, the topography of Central Visayas is rugged and is characterized by highlands dominating the interior of the provinces, with narrow strips of arable land lining the coast. Of the region's total land area, the hilly to mountainous areas (those with slopes above 18%) constitute about 62 percent and the level to rolling lands account for the remaining 38 percent.

The survey in Central Visayas region was conducted in Bohol and Cebu. Bohol has an area of 411,726 hectares. The province is the 10th largest island in the country.Unlike the other three provinces, Bohol is generally flat. Forty-seven (47) percent of the area has a slope of between 0-18 percent. It is not surprising thus, that Bohol should have vast tracts of agricultural lands which are found mostly in the interior of the province. In the interior region are found numerous haycock hills popularly known as the “Chocolate Hills, which have become tourism attractions. One of the larger islands is Panglao located off Tagbilaran City which today has become a major tourist destination in the country.

Cebu province is composed of islands and islets, the largest of which are Mactan, Bantayan, and Camotes. The province has a total land area of 508,840 hectares which is 34 percent of the region's total area. The province's terrain is rugged and mountainous with low peaks forming a mountain range that stretches in the center of the island from the southern tip of Santander to Medellin in the north. The surface is characterized by sharp ridges. Osmeña Peak at 1,034 meters is the highest point of the island. The hilly to mountainous areas (slope of 18 percent and above) account for 68 percent of the province's total land area [26].

Davao

Davao is located on the southeastern portion of Mindanao with a total land area of 2,035,742 ha. And has a population of 4,468,563 (Table 1). Davao has highest GDRP and highest share of employment in agriculture. It encloses the Davao Gulf and its regional center is Davao City. The region has Type II climate classification [4]. Agriculture is the main economic activity in the region and banana is the primary agricultural product produced. In 2007, the region produced a total of 3.1 metric tons - the highest among the regions. Other primary products include rice, corn, coconut, coffee, pineapple, sugarcane, durian, root crops, vegetables, livestock and poultry, fishing, timber and cut flowers. While the region's economy is predominantly agri-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 in Davao City and Davao del Norte [4, 26].

The Province of Davao del Norte is situated at the southeastern part of the region. It has a rugged, mountainous and moderately to steeply sloping areas on the western part and a wide alluvial plain on the central lowland area. A major portion of the alluvial plain is a flat tract of land; however, some places are gently undulating and exhibit a rolling topography. Its local commodities were abaca, banana (Cavendish/Cardava), cacao, coffee, durian, mango, vegetables, rubber tree, among others [12]. It has a population of 945,764 [27].

Davao City is the center of Metro Davao and has an area of 244,000 hectares, or 8% of the land area of Region XI. It is located in the southeastern part of Mindanao and the Southern Gateway more particularly to and from the neighbouring countries like Indonesia, Malaysia, Brunei, Australia, among others.

A substantial part of Davao City is mountainous characterized by extensive mountain ranges with uneven distribution of plateaus and lowlands. The mountain range that delimits the western boundary of the city extends as far down to South Cotabato. This mountain range nurses the highest peak in the Philippines, which is Mt. Apo located at the boundaries of

North Cotabato, Davao del Sur and Davao City. Mt. Apo has an elevation of about 10.311 feet (3,144 meters) above sea level. It has been considered as semi-active volcano.

Davao City enjoys a mild tropical climate. Compared with other parts of the Philippines in which there is a district hot and wet season. The city is outside the typhoon belt and lacks major seasonal variation. A surrounding mountain chain protect the city effectively from strong winds [11]. The city has a population of 1,449,296, making it the most populous in Mindanao and fourth-most populous city in the country [27].

3.2 Data collection and analyses

Survey design

A household survey was conducted with 234 farmers in 2012-2013 in selected provinces in Calabarzon (i.e. Batangas, Quezon), Central Visayas (e.g. Bohol, Cebu) and Davao (i.e. Davao City, Davao del Norte).

Questionnaire were 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 are answers to the following questions:

- What is your gender?
- How old are you?
- What is your level of education?
  (1) grade school, (2) secondary school, (3) undergraduate (bachelor), (4) graduate (master/doctor), (5) technical training, (6) others
- How will you describe the location of your domicile/home?
  (1) urban area/city, (2) suburban area/close to city, (3) industrial/commercial area, (4) mountain/forest area, (5) farm/agriculture area, (6) riverside/coastal area, (7) others
- Where are you presently working? (1) Luzon, (2) Visayas, (3) Mindanao

Sources of information on bioenergy are answers to the following question:
How important are the following sources of information in building your opinion on bioenergy? Please choose from the following: (1) Least important, (2) Relatively important, (3) Most important, and (4) Not important.

- media (television, newspaper)
- internet
- family and friends
- work colleagues
- neighbours
- public officials
- academe/science
- business partners

Knowledge and opinion on bioenergy are answers to the following questions:
Please answer (1) Yes or (2) No

- Are you familiar with the term “bioenergy” (also known as biofuels)?
- Is your work related to bioenergy?
- In your opinion, is bioenergy good or bad for your country?
- 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 are answers to the following questions:
How will you rate the potential contribution of the following food crops (and non-food) for the sustainable production of first (and second) generation bioenergy in your country? Please choose from the following: (1) Very low, (2) Low, (3) High, (4) Very high, (5) Do not know

- sugar-rich crops (e.g. sugarcane, sugar beets)
- starch-rich crops (e.g. corn, sorghum, wheat, potato, cassava)
- oil-rich crops (e.g. soybean, rapeseed, palm, coconut)
- agriculture and forest residues (e.g. stalks, leaves)
- fast-growing trees (e.g. eucalyptus, poplars, jathropa)
- perennial grasses (e.g. switchgrass, miscanthus, bermudagrass)

Factor analysis

We applied factor analysis 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 (see below). Factor analysis is a multivariate analysis procedure that tries to identify underlying variables, or factors, that explain the pattern of correlations within a set of observed variables. It is often used to reduce data to categorize a small number of factors that explain most of the variance that is observed in a much larger number of manifest variables.

To determine if data is appropriate for factor analysis, we should verify if the sampling is adequate for analysis using diagnostic tests, such as Anti-Image Correlation Matrix, Bartlett's Test of Sphericity and Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO). The KMO measures appropriateness of factors in the analysis; only values not below 0.50 are acceptable, otherwise, unacceptable which means that the factor group is not good and individual variables should be examined (i.e. using anti-image correlation matrix) to eliminate unnecessary variables. Chi-square statistic was used to investigate whether distributions of categorical variables differ from one another. It is a test of goodness-of-fit of the data included in the factor analysis. If significance level of the chi-square statistic is higher than 0.05, then the data included in the factor analysis has goodness-of-fit, meaning they are appropriate and acceptable. Associations will enable "loading" of variables into factor components (e.g. rotated component matrix). To check how well the variables have loaded (or bundled) together, we used the Bartlett's Test of Sphericity to determine the level of significance of the correlation matrix. Loading of variables is only possible if Bartlett's Test is statistically significant. The criteria for acceptability of a factor solution were based on exclusion of items with factor loadings less than 0.60. The Bartlett's test, which shows that variables in specific factor analysis are correlated and thus belongs together in the factor group, is statistically significant.

The next step in the factor analysis is to extract the factors and the most popular method is called a principal component analysis (developed by Hotelling, 1933), which determines how well the factors explain the variation. The goal here is to identify the linear combination of variables that account for the greatest amount of common variance [23]. The extraction is based on eigenvalues. Eigenvalues is the total variance explained by each factor. The value of total eigenvalue should be at least 1.00. A factor with less than 1.00 does not have enough variance to represent a unique factor, in this case, the factor should not be considered in the analysis. Screen plots were also evaluated to determine how many factors to include in the succeeding clustering model. The screen plot is a graphical illustration of the incremental variance contributed by each factor in the model. It determines the number of factors in the model such that when the screen plot or factors start to level off, these factors are usually or need to be excluded from the model. Finally, we used the rotated component matrix to identify the variables that loaded together or could be combined and if any variable should be dropped. The method used for the factor rotation is varimax, which minimizes the number of variables that have high loading on each factor. The rotated component matrix presents the variables according to their variance contribution, i.e. largest at the top of the list, thus allowing identification of the most important variables.

Cluster analysis

Cluster analysis groups data objects based only on information found in the data that describes the objects and their relationships. The goal is that the objects within a group be similar (or related) to one another and different from (or unrelated to) the objects in other groups. The greater similarity (or homogeneity) within a group and the greater difference between groups, the better or more distinct the clustering [7]. Cluster analysis does not identify a particular statistical method or model, as do discriminant analysis, factor analysis, and regression. No need to make any assumptions about the underlying distribution of the data but it forms groups of related variables, similar to that of factor analysis [8].

In this paper, cluster analysis aimed to categorize farmers' into clusters and determine how many 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 component variables generated from the factor analysis were used as input to the cluster analysis, which follow two-step approach - hierarchical and K-means clustering.

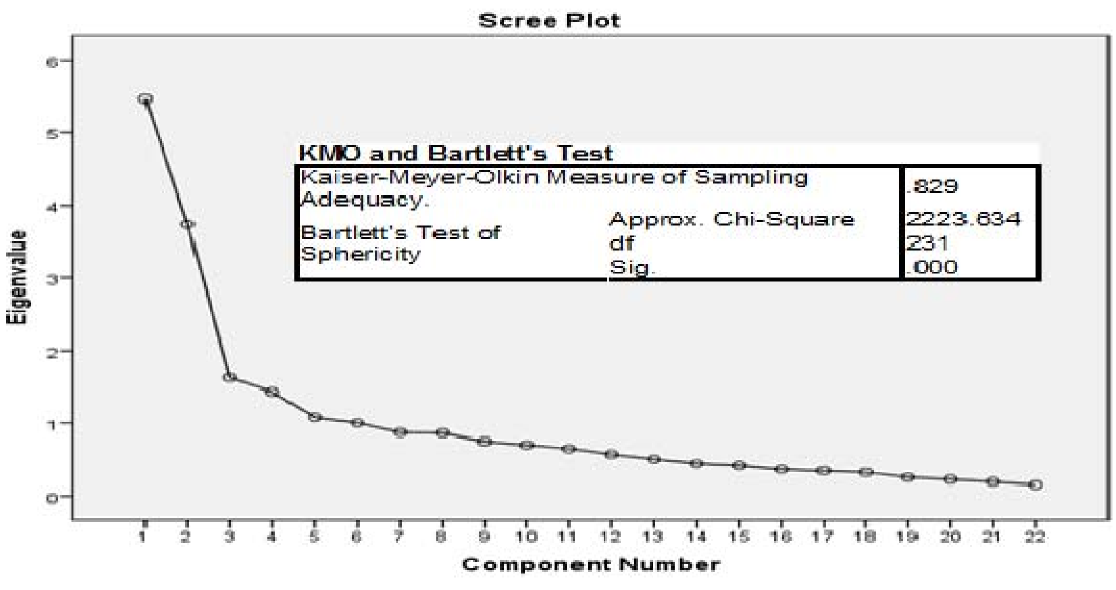
Hierarchal cluster analysis is the main statistical approach for finding homogeneous clusters of cases based on measured characteristics. The method used was between-groups linkage based on squared Euclidian distance. A hierarchical tree diagram, called a dendrogram on SPSS was used to determine the linkage points or a graphic visualization of the results of the hierarchical clustering procedure. It gives an idea of how great the distance was between cases (i.e. respondents) that are clustered (i.e. the closer the distances, the smaller the differences in between the cases, and vice versa). These differences can be traced from the branches of the dendogram so that cases interconnected in a branch are expected to be closely similar and thus belong to a specific cluster. Similarly, those that closely gather around other branches make the other groups of clusters. Next is K-means clustering, a procedure that doesn't require computation of all possible distances. It differs from hierarchical clustering in several ways. You have to know in advance the number of clusters you want. You can't get solutions for a range of cluster numbers unless you rerun the analysis for each different number of clusters. The algorithm continually reassigns cases to clusters, so the same case can move from cluster to cluster during the analysis. The algorithm is called k-means, where k is the number of clusters you want; since a case is assigned to the cluster for which its distance to the cluster mean is the smallest [7].

4. Results and discussion

4.1 Factors and their regional variation

Figure 2 shows the screen plot where there are five component factors generated from 22 variables with eigenvalue greater than 1.00. The results of the KMO and Bartlett's test that are imbedded in this figure show that the results of factor analysis are statistically significant. The Kaiser-Meyer-Olkin (KMO) which measures the appropriateness of factors analysis has value of 0.829, thus exceeding very much the minimum requirement of 0.50. Bartlett's test is another indication of the strength of the relationship among variables. The principal component analysis requires the probability associated with Bartlett's Test of Sphericity be less than the level of significance. The probability associated with the Bartlett's test is <0.001 which satisfies the requirement. Bartlett's Test of Sphericity, is used to determine the level of significance of the correlation matrix

FIGURE 2 Screen plots of input variables



The description of the five component factors is presented in Table 2, which shows the name of variables that loaded together in a component and the variance of their eigenvalues. The first factor component consists of variables that measure sources of opinion on bioenergy and all these variables are highly correlated with this factor; second factor is sources of bioenergy feedstock; third is socio-economic factors including age, domicile and education; fourth is familiarity with and work related to bioenergy; and fifth factor is food security and energy source. The variables for each factor are highly correlated to their designated factor. The eigenvalues of all five component factors are more than 1.00. For the % of variance, we present results from the rotation sums of squared loadings, the values of which characterized the distribution of the variance after the varimax rotation. The varimax rotation tries to maximize the variance of each of the factors, so the total amount of variance accounted for is reallocated across the extracted factors. Each row contains the percent of total variance accounted for by each factor, wherein, the first factor accounts for 22.817% of the variance, the second 17.469%, the third 7.257%, the fourth 6.679% and the fifth 5.501%. For cumulative %, this column contains the cumulative percentage of variance accounted for by the current and all previous factors. For this analysis, the fifth row has a value of 59.719, which suggests that the first five factors collectively account for 59.719% of the total variance.

Table 2 Rotated component matrix and variance of rotation sums of squared loadings

Variables	Component					Rotation Sums of Squared Loadings		
	1	2	3	4	5	Total Eigenvalues	% of Variance	Cumulative %
Work colleagues	.859					5.020	22.817	22.817
Family and friends	.859							
Academe/science	.839							
Public officials	.831							
Neighbours	.799							
Media (TV, newspaper)	.690							
Business partners	.684							
Internet	.639							
Sugar-rich crops		.839				3.843	17.469	40.287

Perennial grasses		.821						
Starch-rich crops		.816						
Fast growing trees		.803						
Oil-rich crops		.765						
Agriculture & forest residues		.568						
Age			.751					
Domicile			.631			1.595	7.252	47.539
Education			-.558					
Familiar with bioenergy				.809		1.469	6.679	54.218
Bioenergy work related				.808				
Affects food security					.797	1.210	5.501	59.719
Bioenergy source					.486			

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Table 3 compares the different case study regions according to the most important variables identified from factor analysis. Large number of famers in Central Visayas considers many important sources of information on bioenergy. The most important source for the three regions is media (TV, newspaper), while internet is the least source of information because most of the farmers live in farm, where internet is not that accessible in the area. Only media is considered most important by half of surveyed famers in Davao. Perceptions on potential on sources of bioenergy feedstock, for both first and second generation, tend to be similar across all three case study areas, i.e. high potential level, except for perennial grasses in Calabarzon where it has low potential as feedstock source. Second generation bioenergy feedstocks are argued to be more sustainable because they do not use food crops and thus not affect food security, and they can be planted in marginal areas or less productive land (e.g. grasses). 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 and retired age and live in rural area, while farmers in Davao are in their middle and retirement age and great number of farmers live in rural area.

Table 3 Regional comparisons of most important variables

Factors	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 %
Neighbors	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 %
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 %
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 %
Familiar w/ 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 %
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%
Work Region	49.57%	24.79%	25.64%
Gender			
Male	50.86 %	51.72 %	58.33 %
Female	49.14 %	48.28 %	41.67 %
Bioenergy is good	98.28%	100.00%	100.00%

Familiarity with “bioenergy” or “biofuels” is highest in Davao and lowest in Calabarzon, however works of farmers in Calabarzon is somehow related to bioenergy compared to Davao and Central Visayas where work were not totally connected. Concerning with their perception if bioenergy is good or bad for the country, all or almost all farmers in the three regions consider that bioenergy is useful but, thus, affect food security when biomass from food crops will be used for bioenergy production. Largest number of farmers who links bioenergy and food security is in Central Visayas. Farmers in 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 and Central Visayas gave the highest potential and lowest in Davao. Most of the surveyed farmers were male except for Calabarzon were gender of farmers were almost equal. On this matter, female should also have knowledge or awareness on bioenergy because they are also part of country’s economic growth or development.

3.2 Clusters and their typologies

A dendrogram, Figure 3, reviews the hierarchical agglomeration process. Objects (i.e. farmers) that group together earlier tend to be more similar in terms of the proximity measure defined. By drawing a line through the dendrogram we can determine which objects belong to which cluster. The further to the right of the dendrogram we draw the line, the fewer clusters will be extracted. The dendogram indicates that the farmers can be grouped into four clusters.

FIGURE 3 Dendogram of the surveyed farmers based on the most important variables

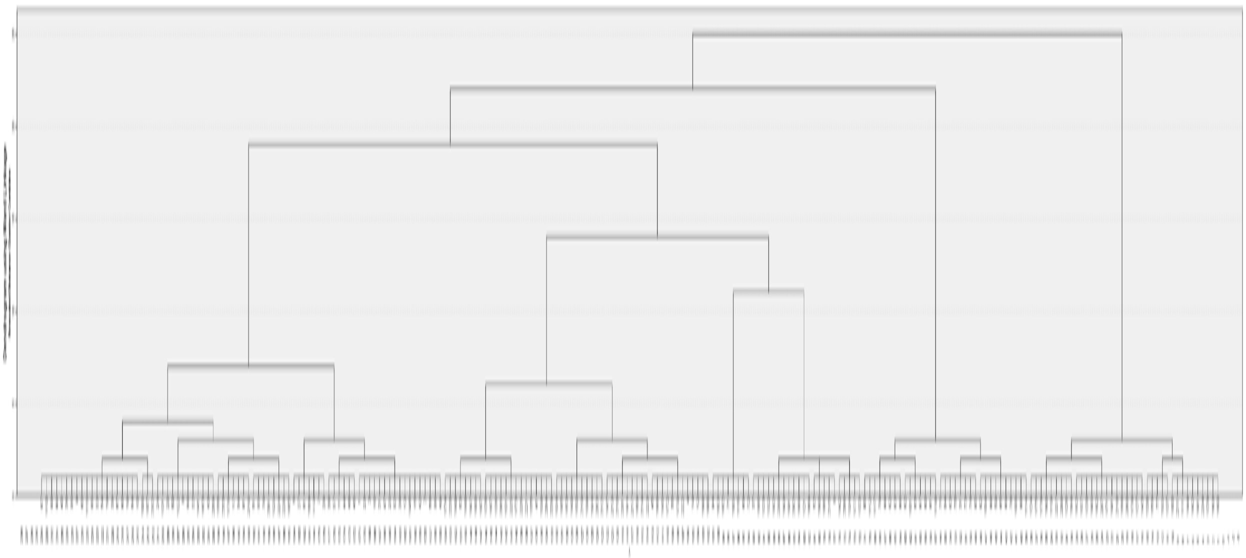


Table 4 interprets the mean case summary for each cluster. Cluster 2 gave the least importance in sources of information in building their opinion on bioenergy but they are educated on bioenergy feedstocks while the other 3 clusters were not; moreover, in socio-economic factors, cluster 2 gave least significance for this factor because most of the farmers, in the other 3 clusters, live in rural areas, average education and, ages were close to retire and retired ages. In relation to familiarity and work related to bioenergy, cluster 4 got negative value because farmers here answered the least who are not familiar with bioenergy (they are the most farmers who are familiar with bioenergy) and almost all farmers are work related to bioenergy; whereas in cluster 2, some farmers are not familiar with bioenergy, for the reason that farmers in cluster 2 are very familiar with bioenergy though works were not related; while in cluster 3, almost all of the farmers are not familiar with bioenergy that’s why they got the highest value; same as well in cluster 1 where great number of farmers are not also familiar and at the same time, they consider that their jobs, in cluster 1 and 3, were not also related to bioenergy. For food security and bioenergy source, cluster 2 and 3, who happened to have negative values, gave the least answer that it will not affect food security but in fact, they do believe that the production of bioenergy can affect food security, cluster 4 were really undecided or no idea if it will affect food security; and cluster 1, who got the highest value, well, in fact think that it will not affect food security.

Table 4 Mean cluster summary

Factors	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Sources of information	0.146	-0.240	0.167	0.167
Choices on feedstocks	-0.093	0.499	-0.390	-0.482
Socio-economic	0.101	-0.747	0.753	0.486
Familiar and work related with bioenergy	0.572	0.024	0.739	-1.810
Food security and bioenergy source	1.631	-0.335	-0.581	0.157

Based on the responses of the farmers in each cluster on the questions related to the five components factors (Appendix 1), we analyzed the profiles of the clusters which 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:

- **Cluster 1** 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 characterized as “unaware”.

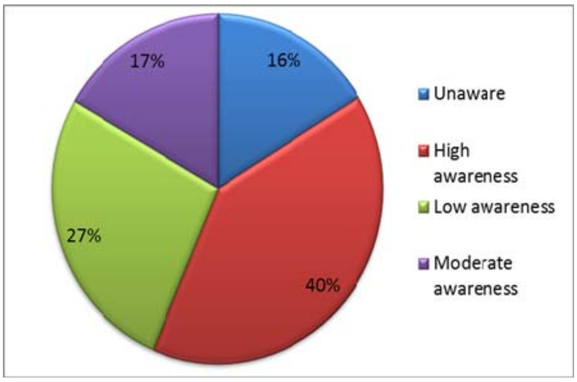
- **Cluster 2** consists of farmers who are middle aged, live in rural areas and highly educated. Media, e.g. TV and newspaper, and internet are relatively important sources of information. They counted non-food crops, such as perennial grasses, agriculture and forest residues, as feedstock to have very high potential contribution for the sustainable bioenergy production. They are the largest proportion of respondents who thinks potential is between high and very high for both non-food crops. They are very familiar with bioenergy although their work is not related to it. They believed that bioenergy will affect food security however it has very high potential for economic growth. As compare to the farmers in other clusters, those in this cluster can be considered very informed and thus have a typology of “high awareness”.

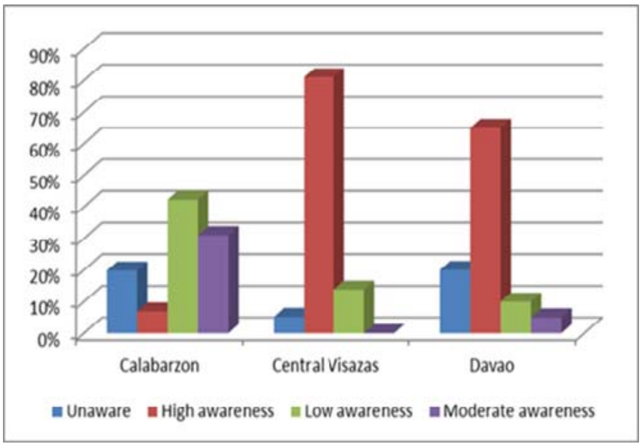
- **Cluster 3** consists of farmers whose age is close to retirement, residence in rural areas, and most important sources of information are family and friends. They consider only oil-rich crops to have high potential as bioenergy feedstock. They are not familiar with and consider their work as not 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 then 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 and retired age, live in rural area, educated and neighbors are relatively important source of information. They consider fast-growing trees have average potential for the second bioenergy feedstock. They are most familiar and largely think that their works are related to bioenergy and considered that bioenergy has average potential for economic growth. Regarding food security, farmers in this cluster are not sure about it because half of the total respondents answered that it will affect and other half answered that it will not. The level of awareness of the farmers can thus be considered moderate or typology corresponding to “moderate awareness”.

Figure 4 shows how the farmers are distributed into the four typologies. The largest number of farmers has a typology of high awareness (40%); quarter of them is clustered in low awareness; and almost equal proportion of farmers has typology unaware and moderate awareness. Farmers with high awareness were found predominantly in Central Visayas, next is Davao. Only few farmers are unaware in Central Visayas, while Davao has the least number of farmers who has low awareness. Calabarzon is where greatest number of farmers who has low to moderate awareness were located, also few farmers has high awareness. Unaware or extremely low awareness farmers have equal distribution in Calabarzon and Davao. No single farmer in Central Visayas has moderate awareness.

Figure 4 **Distribution of farmers by typology and region**





4. Discussion and conclusions

This study presents the awareness of farmers on sustainability of alternative bioenergy feedstock and results show that there is variation on farmer's awareness from different case study areas in the country Clustering of farmers from different region where categorized according on their knowledge on bioenergy. Farmer awareness varies from unaware, low awareness, moderate awareness to high awareness typologies. The greatest number of farmers with high awareness typology is located in Central Visayas, followed by Davao while Calabarzon has the least number of farmers with high awareness on bioenergy.

Farmers with high awareness is greatest in Central Visayas for the reason that 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 were information reaches farmers ahead of time, are the significant factors that give farmers the additional information and knowledge, while farmers in Calabarzon and Davao mostly reside in rural areas and already in their retirement and retired age. Socio-economic factors have great impact on farmer's knowledge, together with farmer's sources of information and farmers with high awareness thinks media and internet as important sources and Central Visayas considers many sources of information. Farmers in this typology, though their work was not related to bioenergy, see non-food crops to have potential for bioenergy to be sustainable.

Farmers with unaware typology were found mostly in Calabarzon and Davao where they have the same proportion of farmers. And farmers, in this typology, source of information came also from other farmer, consider oil-rich crops to have high potential as feedstock's and believes that it will not affect food security but if this can contribute to country's economic growth is uncertain for them.

The largest numbers of farmers with low to moderate awareness were located in Calabarzon. Farmers most important sources of information came from their family, friends and neighbors. Farmers with low awareness typology are not familiar with bioenergy; consider oil-rich crops as feedstock and it can contribute to economic growth because for them this will not affect food security. Farmers with moderate awareness are mostly familiar with bioenergy and consider second-generation bioenergy feedstock, fast-growing trees, for the country to grow or develop but vague if it will affect food security.

Farmers should have understanding on this issue in view of the fact that they are the primary sector that will be involved whenever mass production of biofuels in the country will start off. Sustainability of feedstock for first and second generation bioenergy must be studied holistically to have sustainable production so that farmers will benefit most for they are the producer of bioenergy feedstock. Therefore, overview on bioenergy feedstock and production must be introduced to farmers for them to be familiar and aware.

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