Research article

Productivity and Sustainability of Coconut Production and Husk Utilization in the Philippines: Coconut Husk Availability and Utilization

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Abstract The technical possibility to manufacture fibreboards based on coconut husk and bonded with tannin adhesive formulation was shown. However, there were limited information on the husk production in different coconut producing provinces in the Philippines. Surveys and interviews were conducted to assess husk productivity and utilization by the smallholder coconut farmers. In 2014 and 2015, a total of 13 top coconut producing provinces in the Philippines were surveyed. A total of 1,200 coconut farmers were interviewed. A total of 200 nuts were sampled from the six provinces in the Philippines to characterize husk of coconut. Statistical analysis results showed that the weight of husks are significantly different ($p \leq 0.05$) between the provinces across the islands. The heaviest husks (dry weight) were in the province of Northern Samar (463 ± 11 grams). The mean density (ton ha^{-1} yr^{-1}) of husk production in the 13 provinces was analyzed using the Geographic Information System (GIS) spatial analyst tool. Among the 13 provinces surveyed, Davao Oriental in Mindanao had the highest density (0.70 – 1.43), followed by Camarines Sur (0.66 – 1.29) in Luzon. In the Visayas, Northern Samar (0.55 – 1.17) has the highest density.

Keywords coconut, sustainability, husk production, husk utilization

INTRODUCTION

Husk production in the Philippines is 14.69 billion nuts per year and farmers use more than 5 billion of them for firewood during copra drying (PCA, 2015). The remaining husks become farm waste and large volumes are left in the field together or without the shell. The Department of Agriculture (DA) of the Philippines estimated 9 billion husks are left or burnt in the field (DA, 2014). This massive amount of husks might represent an important natural resource (Greer, 2008). Fibres are extracted from the husk of the coconut and are made into geotextile and a variety of manufactured articles such as ropes, bags, mats, rugs, carpets and many other products (Kavitha, 2016). Meanwhile, the coconut peat –the non-fibrous part of the husk– is also utilized as

component of organic plant media fertilizer (Nazari et al., 2011). In spite of all the current applications of husk mentioned, the estimated husk utilization in the Philippines amounts to 334 tons/day (about 120,000 tons/year) which is a negligible fraction of the total husk production (PCA, 2015).

Niro et al., (2016) showed the technical feasibility to produce fibreboards made of milled coconut husk and bounded with natural adhesives, specifically tannin-based adhesive formulations. To ensure the sustainability of the board production, the husk availability and current utilization should be fully assessed. However, there was limited information on how much volume is actually produced, utilized and therefore potentially available in certain provinces in the Philippines.

This study was conducted to assess husk availability, density and utilization in the major coconut producing provinces in the Philippines. The data were collected with the main aim to provide baseline information for the identification of most suitable locations for the setting up of new coconut husk processing plants, e.g. coconut husk fibreboard manufacturing.

OBJECTIVE

1. To characterize the husks in selected provinces in the Philippines;
2. To assess the husk production and utilization in major coconut producing provinces in the Philippines; and
3. To conduct spatial analysis on husk production and utilization using Geographic Information System (GIS).

METHODOLOGY

Site Selection and Secondary Data Collection

Official visits to the regional and provincial offices of Philippine Coconut Authority (PCA) and Office of the Municipal and Provincial Agriculturist was conducted to collect secondary data (i.e., coconut farm in hectare and production per province and municipality) on coconut production and farming related activities in the locality. In addition, secondary data on coconut production was also obtained from the Philippine Statistics Authority (PSA).

A total of four (4) provinces in Luzon, five (5) provinces in Visayas and four (4) provinces in Mindanao were selected during the 2014 and 2015 survey period. These provinces were pre-determined as the top coconut producers in the major island based on the official data from PCA.

Field Survey and Interview

Using the pretested survey questionnaire, primary data on farming profile which include husk production and utilization from coconut smallholder farmers were collected. Prior to the interview to the coconut farmers, official visits to the regional and provincial offices of PCA as well as from the local government units (i.e., provincial, municipal and barangay/village) were done. The visit was conducted to coordinate the survey with local officials and PCA personnel who are knowledgeable in the area.

The survey was conducted in 2014 and 2015 constituting a total of 900 and 300 respondents (coconut farmers), respectively. During the 2014 survey period, two provinces in Luzon and Mindanao while three provinces in the Visayas were surveyed. Whereas in 2015, two provinces in each major island were surveyed. On the other hand, the respondents were randomly selected based on their availability and willingness to provide information.

Husk Sampling

Aside from the coconut farmer and husk processor survey, 200 samples of husk were collected in the provinces of Laguna, Sorsogon, Northern Samar, Bohol, Surigao del Norte and Agusan del

Norte. The husks from the provinces of Laguna, Sorsogon, Northern Samar, Surigao del Norte and Agusan del Norte were collected from the newly (fresh) harvested whole coconuts. While in Bohol, the husks were collected from already harvested stock nuts in the field. All nuts were individually weighed using a 25 grams mark off top loading balance right after harvesting except on the samples from Bohol. Coconut harvesting and weighing last out an average of 4 hours.

After weighing the nuts, these were manually dehusked using a sharp and pointed tool. Right after dehusking, the husks were then individually weighed to obtain the fresh weight ratio of the husk to the whole nut. After weighing, approximately 100 grams samples (fresh weight) from the whole husk were placed and sealed in a plastic bag brought to laboratory for analysis. These husk samples were oven dried at 70°C for 24 hours (PCARR, 1980) for moisture content determination. The moisture content (%MC) was calculated using Equation 1:

$$\%MC = (\text{Fresh husk weight} - \text{Husk oven dry weight}) / (\text{Fresh husk weight}) \times 100 \quad (1)$$

Gross and Net Husk Density Determination

The gross and net husk density (dry weight) was determined using the harvest yield data collected during the field survey. These was calculated based on the following formulae:

$$\text{Husk density (gross)} = (\text{Total dry husk weight}) / (\text{Coconut farm area}) \quad (2)$$

$$\text{Husk density (net)} = \text{Husk density (gross)} \times (1 - (\text{Percent annual husk utilization}) / 100) \quad (3)$$

Data Encoding and Statistical Analysis

All figures gathered during the survey were collated, encoded and summarized using an electronic spreadsheet editor (Microsoft Excel 2013). A numerical code was provided for each variable of the recorded data.

The data were analyzed using the Statistical Packages for Social Studies (SPSS Version 20). The variabilities of the means on husk fresh and dry weight, moisture content (wet basis), and husk production were analyzed using the one-way analysis of variance (ANOVA). In case significant variations at $p \leq 0.05$ were identified, Duncan multiple range test (DMRT) and least squares differences (LSD) were carried out to compare means of independent variables between different provinces for each major island and between islands. Data with no significant relationship (e.g. husk utilization) were qualitatively analyzed by SPSS.

Mapping of the Spatial Gross and Net Husk Production

The Global Positioning System geographical coordinates of each interviewed farmer was used in mapping the spatial distribution of husk production and utilization. Secondary geo-data of polygon vector at municipal and/or barangay level was obtained from PhilGIS. Using the vector polygon, basic maps on the spatial husk availability were generated using ArcGIS (version 10.2) program through the *Spatial Analyst* and *Network Analyst* tools. The mean value on gross and net availability of husks density (ton ha-1 yr-1) were spatially presented using the PhilGIS vector polygon at the barangay/village level. In addition, the ArcGIS feature to point data management tool was used to generate representative point locations on the husks density data in a barangay level. Using the *kriging spatial analyst* tool, interpolation of the husk data was performed following the ordinary linear semivariogram model in a 100 meters raster cell size.

RESULTS AND DISCUSSION

Coconut Husk Biomass Production

The weights of the fresh husk were significantly different ($p \leq 0.05$) within the provinces and across the major islands (Fig. 1). The heaviest husks were in the province of Northern Samar (1,183 ± 29 grams) while Bohol fresh husk weight was the lowest. The weight of fresh husks from Laguna and Bohol does not differ significantly. The observed differences in the weight of fresh husks between some provinces could be the effect of variety and maturity of nuts during harvest.

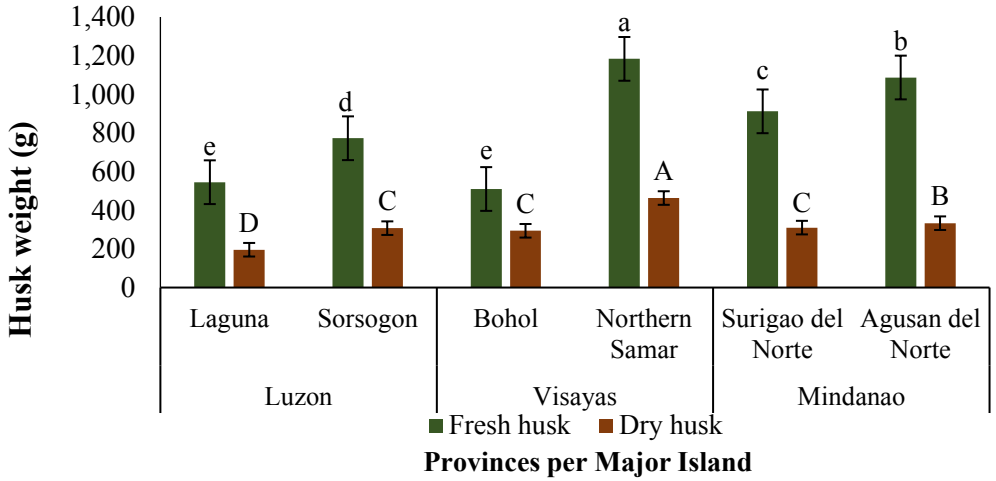

Fig. 1 Fresh and dry husk weight (grams) from the selected provinces the Philippines

Average and standard deviation bars are reported. Values with different superscript letter across province are significant at $p \leq 0.05$; n=200

The dry weight of husks showed as well significant differences ($p \leq 0.05$) and followed similar trend with the fresh husk weights (Fig. 1). Significant difference ($p \leq 0.05$) were observed between the provinces of Northern Samar, Agusan del Norte and Laguna. No significant differences were instead detected between the dry husk weight from the provinces of Sorsogon, Bohol and Surigao del Norte.

Coconut Husk Utilization

The husk utilization by farmers in the three major islands is presented in Fig. 2. The highest percentage of husk use was firewood. Only a small portion of the husks were utilized for handicraft and cococoir (fibres + peat) related productions.

In the three major islands, Visayas has the highest uses of husks for firewood. This is likely related to different copra processing methods in the islands. It was in fact recorded during the interview that in Visayas the copra are dried by the farmers in the field prior to selling to the local buyers. In Luzon and Mindanao island instead, most of the farmers delivers the fresh copra or the whole nut to the buyers. Cococoir processing is mostly concentrated in Luzon and Mindanao.

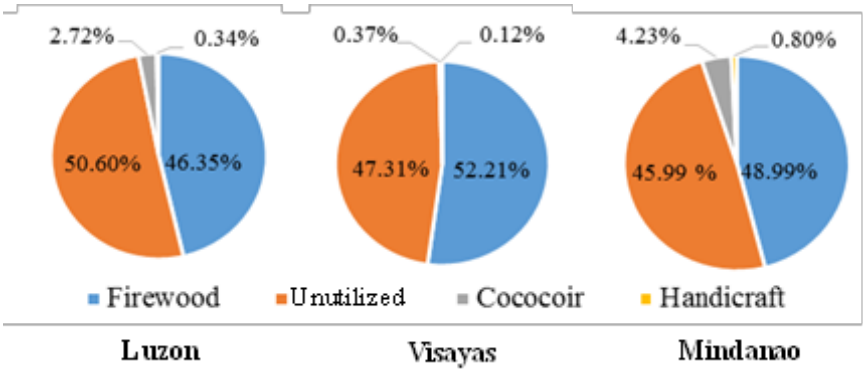

Fig. 2 Percentage of husk utilization by farmers in the provinces from three major islands

Husk Availability in the Different Provinces

Among the top coconut producing provinces in the Philippines, Quezon in Luzon has the largest area of coconut farm of 338,723 ha (Table 1). This was followed by Davao Oriental in Mindanao and Leyte in Visayas with a total coconut area of 143,584 and 126,873 ha, respectively.

Table 1 Gross and net husk density (ton ha^{-1} yr^{-1}) and production from the selected provinces the Philippines

Major Island	Province	Total area cultivated with coconut (ha)*	Husk density (tons ha^{-1} yr^{-1})		Husk production (tons yr^{-1})	
			Gross	Net	Gross	Net
Luzon	Laguna	62,200	1.03	0.52	63,755	32,033
	Quezon	338,723	0.93	0.48	315,012	160,893
	Camarines Sur	119,045	1.29	0.66	153,568	77,974
	Sorsogon	97,153	1.18	0.60	114,641	57,806
Visayas	Northern Samar	85,661	1.17	0.55	99,795	47,114
	Western Samar	49,000	0.99	0.47	48,510	22,785
	Biliran	20,245	0.84	0.40	17,006	7,997
	Leyte	126,873	1.06	0.50	133,851	62,802
	Negros Oriental	45,525	0.80	0.38	36,420	17,072
Mindanao	Surigao del Norte	60,729	0.63	0.32	38,259	19,433
	Agusan del Norte	33,486	0.71	0.35	23,775	11,720
	Misamis Oriental	103,244	0.54	0.27	55,236	27,360
	Davao Oriental	143,584	1.43	0.70	204,607	100,509

**Source: Philippine Coconut Authority (2015)*

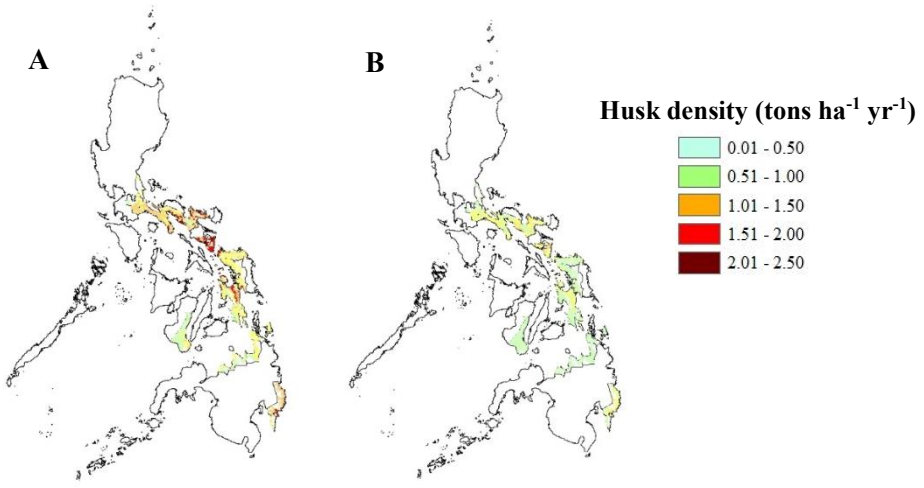

Fig. 3 Gross (A) and net (B) coconut husk production in selected provinces in the Philippines

On the other hand, the highest husk density (Fig. 3) is located in Davao Oriental with a value ranges from 0.70 – 1.43 tons ha^{-1} yr^{-1}. This was followed by Camarines Sur and Sorsogon with densities ranges from 0.66 – 1.29 and 0.60 – 1.18 tons ha^{-1} yr^{-1}, respectively. However, the highest gross and net production of husk is still found in Quezon province. Then again, Davao Oriental ranked second followed by Camarines Sur. The highest husk production is primarily attributed to the total land area planted to coconut. Looking into the husk density between provinces within major islands, Camarines Sur in Luzon, Northern Samar in Visayas, and Davao Oriental in Mindanao were the provinces with the highest husk densities compared to the other provinces.

CONCLUSION

The statistical analysis results showed that the fresh and dry weight of husks are significantly different ($p \leq 0.05$) between the provinces across the islands. The heaviest husks were located in the province of Northern Samar.

The gross and net husk density (ton ha^{-1} yr^{-1}) was highest in the province of Davao Oriental in Mindanao compared to the other provinces surveyed. The highest total husk production was recorded in the province of Quezon.

The gross and net husk density are the major parameters in selecting the site for fibreboards made of milled coconut husk processing plant. Based, on the result of GIS spatial analysis Davao Oriental province with the highest density of husk is the most suitable site of a husk processing plant.

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