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Who Wants to Adopt Sustainable Charcoal Production?: Determinants and Willingness to Adopt Sustainable Practices Among Small-scale Producers in Quezon Province, Philippines

ABSTRACT

Charcoal and wood fuel supply energy needs in both urban and rural communities in the world. In the Philippines, charcoal is used in both commercial and residential in the provinces of Southern Tagalog the National Capital Region (NCR). However, charcoal-making is also one of the main threats to the natural resources and environment in the Philippines. Thus, there is a need to develop a sustainable charcoal production process that could meet the demand without decreasing forest and tree cover. This paper describ present charcoal production practices of households and their willingness to adopt sustainable charcoal practices. It surveyed 85 active charcoal producers in the municipality of Mulanay, Quezon Province, Philippines, to elicit response and document the local practice. An ordered logit model was used to analyse factors that could influence willingness to adopt sustainable charcoal practices.Despite the unprofitable and inefficient charcoal practices, the present practice continues. Under the scenario of increased profits realized through minimum capital requirement, respondents were willing to develop and adopt sustainable practice of charcoal production.

Key words: *charcoal production; sustainable practice; forest resources; willingness to adopt; smallholder farmers*

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INTRODUCTION

Globally, charcoal production is one of the oldest practices in rural communities that contributed in shaping urban communities (*Bensel 2008; Bensel and Remedio 2002; Cruz et al. 1991; Bawagan 1989*). For many years, charcoal production was considered as a forest-based enterprise providing livelihood opportunities among smallholder farmers in the rural areas in the Philippines and other developing countries (*ADB 1995*).

Charcoal is a grey carbon residue more commonly used in residential, industrial and commercial sector as alternative source of energy (*Asian Development Bank 1995*). The raw materials used which could be coconut husk, mangrove wood, or some other biomass, differ depending on locality, country and region. The process of transforming biomass to charcoal is called pyrolysis which requires igniting raw material to a certain temperature for a prolonged period of time (*Bensel et al 2003; Orozco-Levi et al, 2004; Gumbo, 2013*).

Wood is composed of approximately 50-70% weight cellulose, polysaccharides, and about 30% weight lignin, skeletal network of polymers that provide structural integrity of the wood (*Laird 2008*). Pyrolysis is a process which breaks down the cellulose and lignin in the wood into complex chemicals under high temperature with the absence of oxygen. By-products of water steam and aqueous phase, wood tars and oil, gases and wood vinegar or pyro ligneous acid are produced as wood and converted to charcoal (*Orozco-Levi et al. 2004*). The amount of by-products produced varies depending on the method, temperature, moisture content, and type of wood used. At most, recovery rate from pyrolysis ranges from 8-20% depending on technique, technology and knowledge of producers (*Inzon 2013; Luoga et al 2000*).

Based on computed recovery rate, a constant demand for charcoal in rural and urban areas would increase pressure on forest and tree resources, and the number of people to cut and produce more with smaller fluctuation in farm gate prices. An assessment of the drivers of deforestation and forest degradation showed that next to logging, fuelwood and charcoal production were main drivers in developing countries in Africa and Asia (*Hosonuma et al. 2012*). Hence, a national assessment on the impact of charcoal production on forest cover and resource extraction (*Hosonuma et al. 2012*). Sustainable charcoal production is the practice and method that does not completely deplete or extract natural resource beyond its capacity to recover (*Roop 2013; ribot 1998*). It has been a buzz word in rural development studies and research for several years, employing economics and profitability approach to point out that it is unsustainable. Yet, charcoal production continues to exist, which results increased forest resource extraction and land degradation (*University of California Berkley 2000*).

This study focuses on the socio-economic drivers of producers' willingness to adopt sustainable practices necessary to improve the management of the forest resources. This study describeed the charcoal production in Quezon province, Philippines; assess the factors that influence respondents' willingness to adopt sustainable technology; and recommend programs and policy which could address these factors and target these particular groups as candidates to pilot test sustainable practices. In addition, the study looked at the factors which could potentially influence change in behaviours towards sustainable natural resource use and extraction.

Research Site

The research was done in 2012 in 11 villages in the municipality of Mulanay, Quezon province located approximately 279 km southeast of Metro Manila in (**Figure 1**). It covers an estimated 42,000 ha subdivided into 28 villages. It is a coastal municipality located 142 km away from the provincial capital, Lucena City.

The municipality landscape is characterized as rough terrain with a few plains, valley and swamp areas. It has a coastline that stretches approximately 19.22 km facing the Tayabas Bay in the northwest and the Sibuyan Sea in the south. The terrain of the municipality has slopes ranging from 0-- 18% and above. Agriculture and forestry are considered the main sources of livelihood of its residents (85.19%). Agricultural land is registered to banana plantation (20,064 ha) and followed closely by coconut (6,820 ha).

Research Framework

Rural communities and households are caretakers of natural resources and forests in provinces such as Quezon. These caretakers have more access to these resources than most urban dwellers, thus community based management

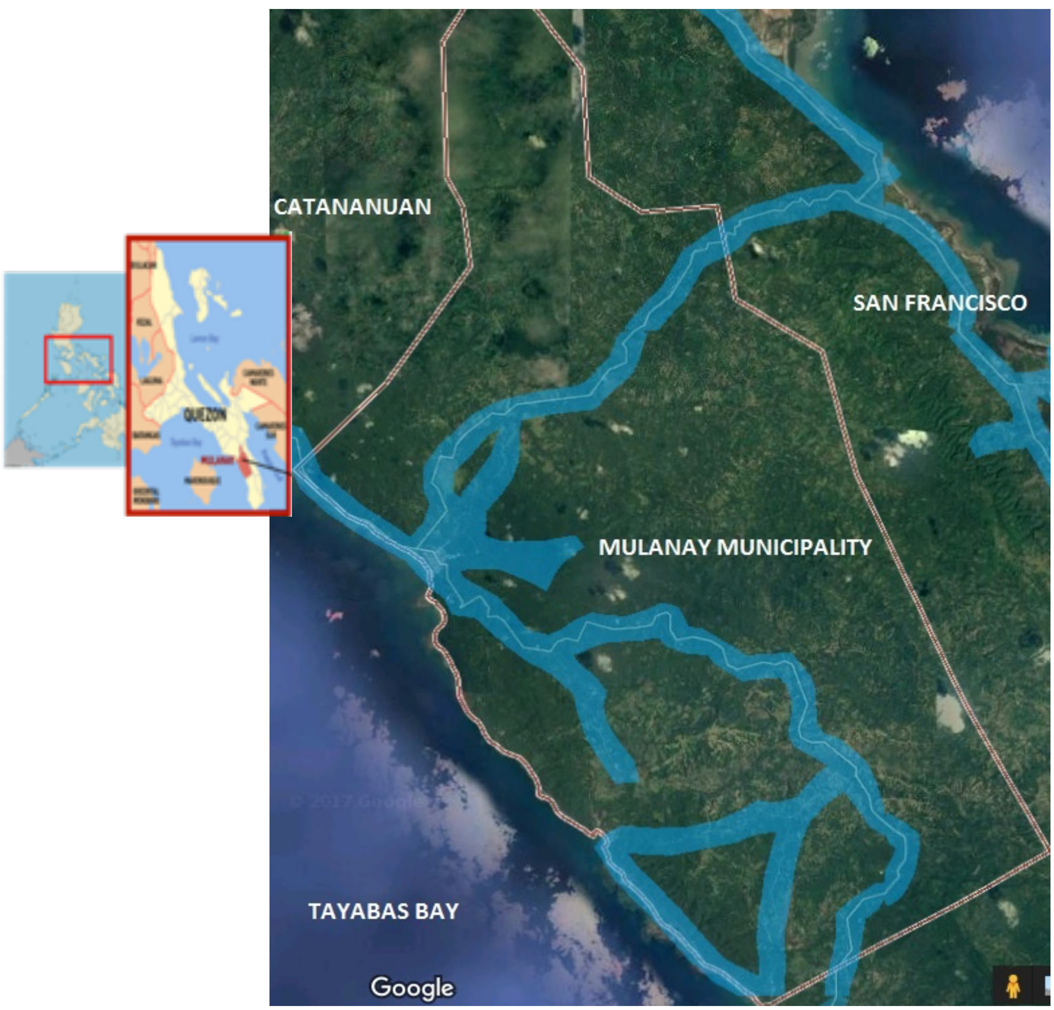

Figure 1. Geographical Map of the Municipality of Mulanay, Bondoc Peninsula, Quezon Province, Philippines. (Source: *Municipal Comprehensive Land Use Plan 2009*).

has been a popular method in enhancing conservation and monitoring efforts. However, despite years of study on sustainable management systems, adoption of sustainable systems remains to be seen. There are several gaps in the analysis, mainly in identifying households' perceptions of sustainable practices and factors which could influence willingness to adopt and triggers of adoption.

This study sought to explain the different factors which could influence charcoal producers' willingness to adopt sustainable charcoal production methods using a logit model. A producer's willingness to adopt sustainable practices could potentially influence how forests and landscapes are utilized by marginalized groups with limited access to technology, information and training. The results aim to implicate policy and program developments for marginalized farmers-charcoal producers.

Sample Population

Due to uncertainty of the actual size of the population of charcoal producers in Mulanay, the study adopted stratified cluster random sampling of known charcoal producing barangays in the municipality. The study focused on 11 barangays that have a history of charcoal production and are heavily involved in agriculture, hunting and forestry industry. The barangays chosen were determined by the recommendation of the Environmental Municipal Officer and the charcoal production cooperative that aided in locating active charcoal producers.

The barangays included were: Bagupaye, Bukal, Burgos, Cambuga, Canuyep, Ibabang Yuni, Ilayang Yuni, Latangan, Mabini, Magsaysay and Sta. Rosa. Bagupaye has the largest number of respondents (23) and active producers with 85 sample size (**Table 1**). The sites were considered due to its relative distance to the main highway with abundant unproductive agricultural lands and known pick up areas for charcoal traders and agents.

Table 1. Distribution of sample respondents by barangay, Quezon Province, 2012.

Barangay	Frequency
Bagupaye	23
Bukal	1
Burgos	2
Cambuga	21
Canuyep	1
Ibabang Yuni	1
Ilayang Yuni	3
Latangan	18
Mabini	3
Magsaysay	9
Sta Rosa	2
Total	85

The study conducted a household survey to collect data on the socio-economic profiles of charcoal-producing households and their perceptions relating to developing sustainable practice. A five-level Likert-scale was used to measure perception of practice and policy which could lead to sustainable charcoal production. The statements introduced in the questionnaire and the following levels: strongly disagree; disagree; undecided/no comment; agree; and strongly agree. These generated idea on how strong or lacking the respondents' agreement or disagreement with given statement.

Data Analysis

Profitability of Local Practice. As an alternative livelihood, charcoal production was considered to be one of the mainstays during the lean months of rice production and recovery of the coconut industry. To be able to assess its financial viability through assessment of the cash flow analysis, the study used the data gathered from household survey on the practice of charcoal production.

An inventory of inputs used at various stages of production was used and was estimated for its value. Rental and acquisition of various inputs such as transport (animal and motor vehicle), kerosene, implements and packaging materials were considered. The number of man hours used at various stages was also considered and equated to the value of local labor cost per day.

In summary, cost per month included inputs such as the number of man hours required to complete the process of charcoal production, implements, equipment and protective gears excluding the raw materials used in charcoal production. A straight-line depreciation rate was used to illustrate wear on equipment and implement. A conservative estimate of 0.05 rate of depreciation with life span of 10 years was computed.

Income from charcoal production (YCHARCOAL) was computed based on the estimated average number of sacks of charcoal produced (AVESACK), estimated mean cycle per month (AVECYCLE) and the estimated average price per sack of charcoal (AVEPHPMO). Thus, the estimated income from charcoal per month is computed as follows:

$$YCHARCOAL\ (PhP/\ Month) = AVESACK \times AVECYCLE \times AVEPHPMO$$

Data generated by the survey was processed to illustrate the practice of charcoal production and its profitability using cost-return analysis with the following equation:

Net Monthly Income (PhP) = Estimated Charcoal Sales per Month (PhP) – Cost per Month (PhP).

Data provided were necessary to generate the income from charcoal production and its relative contribution to total household income as factor which was hypothesized to influence both risk perception and decision to adopt avertive strategies among sample respondents. It provided monetary values to backyard production of charcoal in the locality as well as estimating the unrealized cost not readily identified producers.

Ordered Logit Model. Charcoal producing households are made up of small nomadic who lives on the charcoal site for the duration of the production. They have individual practices which include their adaptation strategies and wood preferences. Literatures on adoption have identified various factors which contribute to the decision of households to adopt technologies and strategies. This study looked at the relationship of charcoal producers' willingness to adopt sustainable practice with hypothesized explanatory variables (**Table 2**). The explanatory variables were selected based on theory and evidence from related adoption studies (*Arellanes and Lee 2003; Del Río González 2009*).

A respondent's willingness to adopt sustainable practice was expressed as an ordinal data (1-strongly disagree; 2-disagree; 3-neutral; 4-agree; 5-strongly disagree). This research theorized that risk perception, household size, years in production, gross charcoal income, migrant, land ownership, total labor hour, perception on shortness of breath, perception on rest after production, and residents' willingness to adopt technology influence household's decision to adopt.

An ordered logit model was used to determine the factors that affect the producer's perception on the willingness to the adoption sustainable practice of the charcoal production. The ordered logit model does not require scoring approach and directly categorizes dependent variables (*Greene 2003; Greene 2008*). It is based from the cumulative probability and cumulative probability logit *Cij* as the probability that an individual is in the *jth* or higher category:

$$Cij = \Pr(y \leq j) = \sum_{k=1}^{j} \Pr(yi = k)$$

The cumulative probability into cumulative logit was derived as follows:

$$logit\ (Cij) = \log(Cij/(1 - Cij)$$

The ordered logit model therefore is expressed

Table 2. Definition of variables used in households' decision to adopt health aversive strategies.

Variables	Symbol	Description
Dependent Variable	YSD	Households' willingness to adopt sustainable practice (ordinal 1-5)
Explanatory Variable		
Age	age	Numerical age of charcoal producers/respondent (continuous)
Sex	sex	Household respondent's sex (1-male; 2-female)
Education	educ	Highest educational attainment (categorical)
Years in residence	yrs_resdnt	Number of years in the municipality
Migrant	mgrnt	Household respondents' place of orgin (0-native; 1-migrant)
Land ownership	truownland	Ownership of land area used for harvest (1-owned; 0-tenant)
Household size	hhsize	Number of members in the family
Estimated gross income from charcoal	char_grs_p	Estimated gross income from charcoal production (gross income charcoal income; Philippine Pesos)
Participation in replanting activities	replantYes	Whether households practice tree planting (0-no; 1-yes)
Distance from harvest area to kiln	dstntkln_hrvt	Kilometer distance from harvest area to charcoal pit
Harvest time	timehrvst	Number of hours used to travel from harvest area to charcoal pit
Risk perception	methodchar	Household identified find practice to be harmful (0-no perception of risk; 1- with perception of risk)
Possibility for improvement	roomimprv	Opinion on whether households' see areas in the practice which could be improved (0-no; 1-yes)
Likert no risk in practice	noriskinchar	Likert scaled variable on identification of risks in the practice (1-strongly disagree; to 5- strongly agree)
Likert practice sustainable	sustnenvrnmnt	Likert scaled variable on perception that present charcoal production is sustainable (1-strongly disagree; to 5- strongly agree)

simply as the cumulative logit model in linear function of independent variables:

$$logit\ (Cij) = \alpha_j - \beta x_i$$

where the variable *Cij* is the ordered dependent variable, *x* is a vector of explanatory variables, β is a vector of parameter estimates. Computing for the odds ratio from logit model aided in establishing the relationship between ordered choice parameter and its interaction effects.

RESULTS

Socioeconomic Description

The knowledge and practice of charcoal production in Mulanay, Quezon, Philippines were mainly from observation and handed down from families, friends and neighbours. An individual producer estimated land area used for harvest was 3.48 ha. Majority of the respondents own and/or have rights to the land which they harvest wood from. The average charcoal producers in Mulanay, Quezon Province were high school undergraduates. The youngest respondent was found to be 15 years old and the oldest 75 years old. The average age of respondents was 35 years old. Average years of residency among respondents were 24 years, and majority of which have an average experience of 3.95 years. The respondents had a maximum of 42 years of experience in charcoal production. The maximum and average years of experience in charcoal production shows the presence of charcoal production in the locality but the low average experience among the sample respondents shows that there is an influx of new producers. Charcoal production therefore will likely continue despite government attempts to curb the production.

Biocharcoal is produced from incomplete combustion of organic material (*Sparrevik et al, 2014*). Majority of the charcoal production is concentrated in rural areas. Pyrolysis takes an average of 100.92 labor hours (*Department of Energy Philippines 2003*). Most common labour used in small-scale charcoal producers is household labour, which is considered as zero expense and is not included in their actual cost of production. Raw materials used are also considered zero production cost as most are just pay in-kind or none at all. As such, computed annual gross income from charcoal production less labor cost was estimated to PhP 17,077.41. Those who produce more regularly have a maximum income of PhP 180,000.00.

Description of Local Charcoal Practice

Stages of Local Charcoal Practices

In documenting the life cycle of charcoal production, the various risk factors practiced by local producers in the study site including the labor inputs, implements and tools used at different stages of production were noted. From *Kituyi* (*2004*). This study focused on three major processes category of the charcoal process, namely extraction, processing and use (**Figure 2**). The process has five sub components, which the farmers identified as production stages: harvest of raw materials; transport and cutting of wood; site identification-construction; pyrolysis/ carbonization; and packaging and transport to market.

The local practice of charcoal production in Mulanay, Quezon involves the gathering of wood and branches and transportation to the selected location. The charcoal site is determined according to availability of space and distance from harvest area and water source. Local charcoal practice uses above ground pits where wood is stacked up to form a box and/or volcano-shaped stack of cut-wood. There are no permanent pits which means charcoal site/pits are sporadically located across the municipality.

The wood is stacked to its desired shape with a small opening tunneling to the center of the stack pile. Once stacking is complete, banana leaves are used as first layer of covering after which the stack is patted down and sealed with mud. After the seal is complete, the producer would light the center using kerosene which they push through the small opening leading to the center. Pyrolysis then begins and approximately 32 hours of monitoring is necessary to gauge the temperature to minimize mass loss.

Implements, equipment and gear used during production in Mulanay, Quezon were enumerated. They use hand tools and animals in transporting the raw materials to the processing site and the finished products to the market. During the pyrolysis stage, only 46% of the respondents used any sort of protective gear which included long sleeved-jackets, long pants, rubber boots, masks and caps. Pyrolysis is considered the longest and hardest stage for producers since manual monitoring and calibrating of the temperature

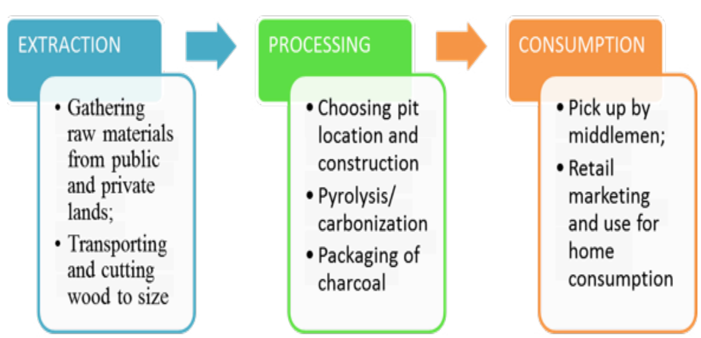

Figure 2. Process of smallscale charcoal production in Mulanay, Quezon Province. 2012.

is necessary to ensure optimum charcoal recovery.

For the duration of the process, producers build make-shift huts serving as shelter during the pyrolysis stage. These shelters are approximately 2.0-5.0 m away from the charcoal pit facing the open heat. Some producers stay in the shelter with their family during the long hours of pyrolysis. During this stage, gasses are released from the combustion process with the producers and their families exposed. The last stage is the packaging and marketing of the produced charcoals. It is done manually by the charcoal producer wearing a specialized protection to minimize exposure to the carbon particles. There are two different ways to market the charcoal: direct selling at local markets or marketing through middlemen.

Profitability of Charcoal Practice

Many studies have focused on economic feasibility of charcoal production as to be able to promote new technology and alternative livelihoods (*Chianu and Tsujii, 2003; Kiyuti 2004; Mwase et al. 2007*). Despite the fluctuation of the farm-gate price of charcoal, respondents continue to practice charcoal production. Many producers consider charcoal production as an alternative livelihood due to its minimal input requirements and predominantly non-monetary labor capital input (*Mwase et al. 2007*). This being said, the study took into account the net income of producers, wives and without household labor expense. The respondents generally earned an estimated gross annual income from charcoal production amounted to PhP 15,439 (**Table 3**). The inputs cost amounted to PhP 2,958, which included the animal rent, packaging materials, tools rental and depreciation.

An estimated net income from charcoal without household labor cost amounted to PhP 12,480. Average annual labor cost amounted to PhP 23,511 for a total of one month operation covering approximately two cycles per month. When the labor cost was accounted for, the production estimated a net loss of PhP 11,031. Since majority of the households did not consider labor as an expense and many do not have additional labor, the producers still considered charcoal production as a profitable enterprise (**Table 3**).

Table 3. Cost and return of charcoal production, Mulanay, Quezon Province, 2012.

Item	Amount (PhP)
Income	
Ave. number of sacks per annum	135
Estimated gross annual income from charcoal	15,439
Cost of Production	
Cost of inputs/annual[1]	2,958
Annual Labor cost[1]	23,511
Net Income from Charcoal Production without labor cost	12,480
Net Income/Loss with labor cost	(11,031)

[1] Inputs include kerosene, transport rental, packaging materials and depreciation of implements

[2] NEDA Agriculture Sector Prescribed minimum wage rate per day of PhP 220.00

Local Perception on Sustainable Charcoal Practice

Charcoal trade is a lucrative business which has profited agents and middlemen. Traders were able to identify one major problem when it came to the charcoal product which mostly with regards to the quality of the product. Most agents buy at bulk and rarely have enough time to inspect for the quality of the whole batch of charcoal. They emphasized that the bulk of the losses they incur was from poor quality of coal which was inspected in the city by the wholesale buyers. The questionnaire were administered to gauge their agreement to a set of statements particularly on their willingnes to develop and implement new technologies. A total of 46 of the respondents agreed to the statement on their willingness to improve the technology and practice of production (**Table 4**).

One of the requirements for the permit to transport was a mandatory tree planting activity and tree replacement for every ton of charcoal transported. This requirement was designed to make the charcoal producers and traders conscious of the environmental impacts of charcoal production and contribute to the and sustainability of the practice. About 45.88% of the sample respondents agreed to this statement. Many of the household respondents considered charcoal production as an environmentally sustainable livelihood at present practice. Despite this, a small mean difference on the views of those who agreed and those who were unsure whether present practice of charcoal production is environmentally sustainable.

Probability Analysis

The empirical model was found to be highly significant at 1% level and the variables were considered a good representation of the determinants of the dependent variable. Among the 16 variables considered, three were found to significantly influence willingness to develop sustainable practice such, residents perception production as sustainable, land tenure, and gross month income (**Table 5**).

The gross income from the willingness to adopt charcoal production was one variable found to be significant at 10.0% error. For one unit increase in net charcoal income, the odds of the combined high and middle rank of willingness to develop sustainable practice are 0.999 times greater when all other variables were held constant. It is consistent with the hypothesized behaviour that charcoal producers with lower income are more likely to adopt sustainable practice.

DISCUSSION

The process of charcoal production in the country and in Mulanay, Quezon have long been considered a threat resulting to land degradation and deforestation. Considering various policies which were aimed to minimize trade of charcoal production across provinces, this study found out the receptibility of charcoal products to younger generations and those with lower experience. Perhaps one of the main drivers for production is the augmentation of income during lean periods of agricultural production or lack of opportunities in the locality. This highlights the Food and Agriculture Organization's (FAO) stand on developing a sustainable means of production both locally and globally (*FAO 2009*). While the need for sustainable practice is necessary to be adopted by producers, alternative measures and practices have not been successfully adopted.

This study supports the hypothesis that a producer is

Table 4. Sample respondents' attitude and opinion on developing sustainable practice in charcoal production in Mulanay, Quezon 2012.

Statement	Frequency				
	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Local residents believe that there is no risk to charcoal production.	14	23	20	27	1
Residents are willing to develop a process which would allow them to continue to produce charcoal.	11	4	22	46	2
Local residents have been made conscious to maintain and improve the environmental of the harvest area.	12	8	26	39	0
Residents view charcoal production as an environmentally sustainable livelihood.	13	11	29	32	0

Table 5. Factors influencing willingness to adopt sustainable practice among small scale charcoal producers in Quezon Province, 2012.

SUSDEV	Odds Ratio	Std. Err.	z	P>z	[95% Conf.	Interval]
age	1.032541	0.028582	1.16	0.247	0.9780137	1.090109
sex (m/f)	0.8388759	0.553898	-0.27	0.79	0.2299648	3.060088
educ	1.383497	0.298295	1.51	0.132	0.9066738	2.111084
yrs_resdnt	0.9806837	0.026294	-0.73	0.467	0.9304801	1.033596
mgrnt	0.843513	0.596863	-0.24	0.81	0.21076	3.375946
truownerland*	0.3050139	0.162289	-2.23	0.026	0.1075026	0.8654066
hhsize	0.8525884	0.125434	-1.08	0.278	0.6390128	1.137547
char_grs_p**	0.9999813	1.08E-05	-1.73	0.083	0.9999601	1.000002
replantyes	2.306239	1.410873	1.37	0.172	0.6952971	7.649592
dstncklnto~m	1.000282	0.000841	0.34	0.737	0.9986347	1.001932
timeharvst	1.002745	0.004133	0.67	0.506	0.9946765	1.010879
methodchar	0.7523879	0.409696	-0.52	0.601	0.2587849	2.187483
roomforimp	0.9021737	0.514159	-0.18	0.857	0.2952436	2.756766
prfrlvlhoo	1.435279	0.362318	1.43	0.152	0.8751073	2.354028
noriskinchar	1.203186	0.35389	0.63	0.529	0.6760379	2.141383
sustnenvrnmt*	3.188966	0.976516	3.79	0.000	1.749837	5.811687
/cut1	1.470127	1.916098		-2.28536	5.22561	
/cut2	2.749464	1.996151		-1.16292	6.661847	
/cut3	5.092526	2.013238		1.146651	9.038401	
/cut4	10.29592	2.266559		5.853547	14.73829	
Log Likelihood	-67.8976					
No. of observed	85.0000					
LR Chi (16)	64.6000					
Prob > chi2	0.0000					
Pseudo R2	0.3224					

willing to adopt sustainable practice if they perceive there is charcoal production is sustainable. The producer's openness to look at charcoal production as a sustainable practice Their land ownership shows higher willingness to adopt sustainable practice. Since charcoal production has a constant demand and persistent production, local and national policy should look at the determinants, which would ensure that charcoal practice is sustainable rather than limiting production itself.

There is a strong positive influence of income from charcoal production on household's willingness to develop sustainable practice. The influence of each variable suggests that those who perceive that present practice was sustainable significantly influences willingness to develop present practice. Income from charcoal production is second to the most likely to influence their willingness, this may be best explained by desire to improve present income from charcoal.

CONCLUSION AND RECOMMENDATION

Charcoal trade is still a thriving industry which borders in the grey areas of legality in the Philippines and the world. While majority of undocumented producers were expected to be nomadic in nature, this study confirms otherwise. Majority of the producers interviewed have secured land tenure but were still engaged in charcoal production as a means to augment income particularly during the lean months. Results showed that income from households increase an average of PhP 12,480 annually without opportunity cost of labor and main raw material. However, producers experience a net loss in income when labor is accounted for. The computation of opportunity cost of the wood was also unaccounted for. Farmers' experience increase income from charcoal production, the higher is the likelihood to adopt sustainable means of production to ensure that their livelihood is protected and sustainable.

This study highly recommends formulating policies that can maximize the charcoal production with little capital requirement to increase the income of charcoal producers. Charcoal practice have a higher risk in terms of health, while it requires little capital which results to its general appeal to the farmers. In general, despite the opportunity cost of labor, charcoal producers argue that there was no opportunity cost of labor given that there is no available opportunity to be considered. This is the general cycle and logic of charcoal production that is often not considered in a number of researches and programs. To be able to consider the opportunity cost, introduction of alternative sustainable livelihood opportunities must be a priority, coupled with a clear understanding on the technical assessment of the charcoal production process, to ensure its sustainability. Development of infrastructures such as kiln sites would efficiently increase recovery rate of charcoal. Strengthening negotiating powers fragmented charcoal producers would increase their farm gate price and overall income.

To be able to control and develop sustainable management for charcoal production, a system of monitoring should be in place to ensure that forest resources are able to regenerate as well as monitoring extraction in harvest areas. Policy and development infrastructure investments are necessary to increase understanding among charcoal producers in protecting the environment. This studyrecommends looking at charcoal production as a permanent livelihood and compared to alternative livelihood practice as this could be one of the main reasons for environmental degradation and resistance to development of a sustainable practices.

Upon observation of charcoal practice and that despite the risks involved in the present charcoal production, bans on the production are not likely to slow down or eliminate charcoal production altogether. There should be clear guidelines to ensure proper charcoal production to minimize the risks to health. The ralization of a policy should improve the practice and more sustainable means of production through the use of more efficient technology.

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