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FUEL WOOD COMMERCIALIZATION AND HOUSEHOLDS WELFARE IN THE NORTHERN REGION OF GHANA: AN IMPLICATIONS FOR RURAL LIVELIHOOD IMPROVEMENT

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ABSTRACT: *Several national forestry policies in Ghana meet resistance and or failure; particularly issues of natural and environment resources use within communities. This is because of the highly dependent nature of people on the environment for sustenance and welfare improvements. This paper examined the major facts which motivate households' decisions to engage in commercialization of fuelwood; determined the most preferred fuel wood species, and availability of income inequality among sampled districts and establish fuelwood, commercialization and households' welfare by the travel cost method. The study sampled six districts in the Northern Region based on poverty and rural dependence mode. The paper used the simple random sample along with a structured questionnaire to illicit information from respondents. The results showed that, increased in travel cost and cost of access to forested sites impact negatively on the number of visits for fuel wood. The study further revealed that, benefits from fuel wood commercialization in terms of reducing income inequality differ from district to district. The study recommended that, government and international organizations should facilitate the cultivation forest sites solely for fuel wood harvest to ensure environmental sustainability. In addition, fuel wood harvesters must be taught forest management and conservation strategies in the Northern Region.*

KEYWORDS: Fuel Wood, Commercialization, Households, Welfare, Inequality, Livelihood

INTRODUCTION

Fuel wood has been defined to be wood whose form is rough and could be branches of trees, logs, sawdust, pellets and twigs mainly for energy generation (FAO, 2002). Fuel wood has played significant role in domestic and commercial energy consumption world over. CIFOR (2009) estimated approximately about two billion people world over use biomass in the form of fuel wood and charcoal for cooking and heating. These people have depended on these natural resources for their survival for a very long period of time.

Human beings have always had a close relationship with environmental resources and therefore take their livelihood from it. Todaro and Smith (2011) put it that, more than half of the developing world inhabitants who are considered very active depend in part or whole on the environment which could be hunting, fishing, agriculture, forestry and so on. Forest and

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environmental resources are considered to have played an important role in both rural and urban livelihoods but particular reference is given to rural livelihood (Walelign, 2013). The rural inhabitants often subsisted through dependence on forest resources and the environment.

Kiflu et al (2009) explained that, researchers on wood fuel use in developing regions of Africa, Asia and Latin America believed that, wood fuel was a major factor in tropical deforestation and thus, accounted for forests loss and widespread wood fuel shortages. However, other studies disproved the notion that, wood fuel harvesting is a direct cause of deforestation since most wood fuel demand is met by trees and shrubs growing outside of forest areas and from farm clearance (Arnold, *et al.*, 2006; Bensel, 2008 cited in Kiflu et al, 2009).

Arnold and Persson (2003) related that, fuel wood consumption in Africa was estimated to increase to 544.8 million m^3 for firewood and 46.1 million tons for charcoal by 2030. Fuelwood is a renewable form of energy that has received substantial harvest in Ghana because of its open source nature. As a *de facto* open-access resources, fuel wood commercialization is often linked to people who do not require a long period of training and experience for harvest knowledge and as such, harvest require simple tools and implements (Belcher *et al.*, 2005; Fu *et al.*, 2009).

Ghana's fuelwood consumption is been increasing for both urban and rural inhabitants. This invariably has motivated many people to engage in commercial harvest of the fuel wood. Estimates from the 2010 Ghana Population & Housing Census showed that, 73% of rural households and 48% of urban households use firewood and charcoal respectively for cooking in 2010 (Ghana Statistical Services, 2010).

The Northern Region of Ghana is homogenous in characteristics and one of the major homogeneous characteristic is poverty. The incidence of poverty and poverty gap increases is one in every two in the Northern region (50.4%) (GLSS 6, 2014). This therefore serve as a motivation for the inhabitants to seek livelihood empowerments in fuel wood commercialization.

Fuelwood is still widely used as a dominant energy among all classes of people across sub Saharan Africa and Ghana is no exception (Amuah, 2011).

The problem of the study is manifested in two arguments: the issue that, some empirical literature stressing the effects of fuel wood harvest on environmental degradation (Anang, 2011; Eco-discipline, 2012) and hence, fuel wood commercialization has therefore fallen prey to the people. The other issue been that, households depend on dead trees, shrubs, and over aged trees as fuel wood for commercialization and not standing tree; therefore, forestry has to be redefined. Forestry in this era has been redefined, and much emphasis is placed on poverty alleviation and livelihoods improvement (Vedeld et al, 2004; Belcher, 2005).

In 2006 then, Ghana Strategic Energy Plan - SNEP (2006 – 2020) is a nationally thought through energy roadmap that provides the country's energy programme was inaugurated (Energy Commission of Ghana, 2006). The policy document was aimed at streamlining energy usage and bringing to light the aspect of energy demand the public is not aware and how effective and efficient utilization could be achieved. Despite this important roadmap document to streamline energy demand in Ghana, usage of fuel wood as a component of the energy mix has been on the increase for both rural and urban populace. IFAD (2001) asserted that, growing population has resulted in harvest of fuelwood as business of potential for cash incomes from

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planned cultivation and management of trees and natural resources; (from 1,820,806 in 2000 to 2, 479,461 in 2010 (2000 PHC; 2010 PHC; GSS, 2010). The complex nature of fuel wood distribution across the actors in the society (harvesters, users, sellers, policymakers, etc) pose a daunting challenges to particularly energy planners. Several surveys in Ghana has put the Northern Region among the regions with high poverty incidence and rates (See GLSS 6, 2014) and this invariably has made the inhabitants seeking alternative livelihoods to empower themselves. The GLSS 5 survey showed that, approximate estimates of 50% of households in Ghana depended both on non-traditional and traditional energy source (Ghana Statistical Service, 2008).

Dominance in fuel wood commercialization has had gender dimension in Ghana both rural and urban areas and could relate to gender dimension to poverty and livelihood alternatives. Women in most cases in the rural settings in Ghana undertake major part of the farm activities including walking to distant places to gather fuel wood. As Sesabo and Tol, (2005) put it, gathering and collecting fuelwood alongside their farming activities involve women walking long distances and this impact negatively on women.

Belcher (2005) related that, poverty has been defined to include materialistic definitions focusing on income and wealth (welfare), to extended definitions that emphasised capabilities and empowerment in addition to the monetary aspects of livelihoods. Belcher (2005) further opined that, to achieve poverty reduction based on forest products, there has to be an increase in the creation of wealth through forest products production, processing and marketing, and to streamline mechanisms to guarantee that some of that wealth is captured by the intended beneficiaries. Thus, commercialization of fuel wood perhaps could enhance welfare.

The motivation of this paper hinges on the following questions: what are the major factors which motivate households' decision to engage in commercialization of fuel wood in the Northern Region of Ghana?; which are the most preferred fuel wood by households' and are there availability of income inequality among participating districts in the Northern Region of Ghana?; how is the linkage between fuelwood commercialization and households' welfare in sampled districts in the Northern Region of Ghana with respect to travel cost method?

The general objective of the study was to assess fuel-wood commercialization and households' welfare in the Northern Region of Ghana. The specific objectives were to: identify the major factors which motivate households' decision to engage in commercialization of fuel wood in the Northern Region of Ghana. Determine the most preferred fuel wood specie by households and availability of income inequality among participating districts in the Northern Region of Ghana. Establish fuelwood commercialization and households' welfare in sampled districts in the Northern Region of Ghana using the travel cost method.

The study hypothesised that fuel wood commercialization and households' welfare in the Northern Region of Ghana are positively and significantly related.

The hypothesis postulation is that: travel cost by individual (household head) has no effect on the number of visit for fuel wood in the Northern Region.

This paper is justified in that, it is an original application of the individual travel cost method derived from cost of access instead of lump used of a model. It brings to bear the contribution of forest income to poverty reduction and the combination Lorenz curves and Gini coefficient

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to measure variation in income among households in the study area. A study of this nature is timely as it provides an opportunity for increased body of knowledge in forest literature.

Empirical Literature

Quite a lot of studies have been done in this field. For example Manyatsi and Hlophe (2010) studied the contribution of sale of firewood towards rural livelihood in Swaziland, and its environmental sustainability. They used Landsat Enhanced Thematic Mapper for 1994 and 2006 for the study. The results of the study showed that, majority of the firewood harvesters had permission from owners and management of the land to harvest. However, the harvesting was not monitored. The sale of firewood to the livelihood of the sellers were between US $ 67 and US $ 133 per month. Their study stated that firewood had contributed to livelihood of the population of Swaziland and this was enormous taken into consideration the poverty levels of the people. Their study has a similarity with this current study in terms of welfare improvement and enhancement in income of the households.

Aabeyir et al (2011) studied factors affecting sustainable commercial fuelwood collection in the Kintampo North District of Ghana for the purposes of sustainable woodland management and fuelwood collection. Using focus group discussion, pair-wise comparison to rank the factors. The results showed that, land tenure and low producer price of fuelwood were ranked first among the factors affecting commercial fuelwood collection; distant collection sites are over 24km from settlements in the study areas. Land tenure system practised in the study area promotes effective management system for sustainable fuelwood collection. However, the study area characteristics differs from the Northern Region of Ghana because the nature of land tenure system practiced there and also the harmonization of the land system.

In addition, Kuunibe et al (2013) employed the logit model to examine the factors determining households' decisions regarding wood-based biomass fuel for cooking purposes in the Upper West region. The result of their study showed that, household size, price of wood, level of education and income had a negative relationship with fuel choice. The study relates to the current study as it sought to determine factors that influence households' fuelwood preferences in the Northern Region of Ghana. The differences however, lies in the methodological approach and estimation procedure.

John et al (2013) undertook a study on charcoal production and household welfare in Uganda: a quantile regression approach. They started their study making reference to empirical literature which suggested that, forest-dependent households tend to be poorer than other groups, and that extreme reliance on forest resources might constitute a poverty trap. They used charcoal as an example of a non-timber forest product which appears to be providing a pathway out of poverty for some rural households in Uganda. They took data from households living adjacent to natural forests, some of whom engage in charcoal production. They then used a semi-parametric method to identify the determinants of participation in charcoal production and a quantile regression decomposition to measure the heterogeneous effect of participation on household income. Their results revealed that, younger households with few productive assets are more likely to engage in charcoal production and as a result charcoal producers are better off than non-charcoal producers in terms of income, even though they are worse off in terms of productive assets. This study has similarity with the current study, the distinction however is reflected in the methodological approach.

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Furthermore, a study by Azeez et al (2014) on the utilization pattern and economic evaluation of fuelwood enterprise: A case study of some areas in Ibadan Metropolis, Oyo State to evaluate the profitability and factors influencing fuelwood profitability among marketers in the study area. They employed Descriptive and quantitative techniques in the analysis of the data. The result showed that majority of households used fuel wood for cooking purposes and that the marketing of this product is highly profitable. The average Profitability Index for all farms was 0.75, indicating that out of every N10 earned; about N7.5 accrue to the marketer as profit after accounting for all cost. Therefore marketing of fuel wood holds a great potential for income generation as it was found to be a very profitable business. This justifies for the current study in this area considering the fact that, both locations have higher rates of employment.

Taiye and Emmanuel (2015) examined the sustainability of fuel wood harvesting from Afaka Forest Reserve in Kaduna, Nigeria. They used field observation, physical measurement of harvested wood diameters, photographing reporting and farmers' interviews. The data was analyzed, by means of descriptive statistics in order to estimate the quantity of wood harvested per day, week, month and year; as well as the sizes of harvested trees and the harvesting method. The results showed that, a daily average of 91.9 tons of wood was harvested from the forest and transported into Kaduna through various classes of vehicles. Approximately, about 15% of the harvested wood had a diameter of less than 5cm, 40% (5.1–10 cm), 14% (10.1–15 cm), 16% (15.1–20 cm) and 15% (> 20 cm). They revealed harvesters did not use any specific scientific method of harvesting and the rate of regeneration and/or replacement planting trees were below the rate of harvesting. They viewed the demand for fuel wood, poverty level, the harvesting cost, and availability of fuel alternatives would affect the rate of wood harvesting. They recommended that, Government at all levels, NGO, CBO should expand the forest and at the same time put in place a sustainable method of harvesting. This support the intent of the current study as fuel wood harvesters in the Northern Region of Ghana share similar characteristics.

The study is limited in scope to fuel wood commercialization and households' welfare in the sampled districts in the Northern Region of Ghana. Improvements in income, households' ability to increase their expenditure on basic goods and services and other basic measurements of welfare are the intended idea of the study. In terms of relevance, the study sought to lay the groundwork as the first study on fuel wood commercialization and households' welfare in the Northern Region of Ghana. There is large information gap in connection with fuel wood commercialization documentation, policymakers seem not to fully regulate the activities of harvesters and those engaged in income generating activities that demand regular fuelwood use. It is also important to put out the impact of the shortages of fuel wood on those whose livelihood heavily depended on fuel wood trade. These arguments thus, stressed the relevance of this particular study.

METHODOLOGY

Area of study, Method of Data Collection and Analysis

This particular study was carried out in some selected districts in the Northern Region of Ghana. The majority of the inhabitants in the region are involved in agriculture (GSS, 2010). According to the Ghana Statistical Service (2010) extreme poverty prevalence is found to be high in rural Savannah and the Northern region is acknowledged to have a rural population

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(69.7%) and thus, poverty in the Northern Region is a notable rural phenomenon. The Northern region is Ghana's largest region regarding land area (70,384 square kilometres), accounting for 30 percent of the Ghana's land mass. The 2010 census data showed that the total number of household heads in the Northern region is 318,119, made up of 270,488 male heads and 47,631 female heads. The data further revealed about 74.0 percent of the people are in unskilled agricultural, forestry and fishery.

The research was a survey aimed at employing quantitative analysis to study the households. Using the Ghana Statistical Service (2010) data, we sampled six (6) districts with high rural dependence on fuel wood as their main source of energy for domestic use. The districts included the Chereponi, East Mamprusi, Sawla-Tuna-Kalba, Karaga, Gushegu, and Bunkpurugu-Yunyoo. The districts selected were homogeneous in terms of income and education. Collaborated from the initial pilot survey, harvesters of fuel wood mentioned the aforementioned districts as the origin of harvested fuel wood. The other motivation regarding the selected districts included: the district level poverty, market access for fuel wood, and households access to the forest for fuel wood (See GSS, 2010).

The data for the study was primary data obtained through the use of structured questionnaire to illicit information from selected respondents. The sample size for the study was 285 by the statistical formula; $n = \frac{N}{1 + N\left(\alpha^2\right)}$

Where: n is the sample size; N (991.027) is the target population and the sample frame

α (5%) is the error margin and the confidence interval is 95%.

A total of 47 households were sampled from each district. Houses were selected randomly and households' heads were interviewed. The study produced a response rate of 99 percent with two protest cases. The data analysis therefore captured 280 respondents instead of 282 respondents.

$$n = \frac{N}{1 + N\left(\alpha^2\right)}$$

Where: n is the sample size

N (991.027) is the target population and the sample frame

α (5%) is the error margin and the confidence interval is 95%.

Information on the fuel wood types were stated in Dagbani for uniformity. Dagbani is the dominant language in the Northern Region. In the various districts, we employed the services of literate inhabitants to translate into the local dialect for questionnaire administration. The data was collected by five (5) trained research assistants in addition to the author. The period for the data collection was November 2014 to April, 2015. This was the dry season period in which fuel wood commercialization was evident. The analysis were based on descriptive statistics including frequency distribution and regression analysis was also undertaken. The Coefficient of Variance and the Gini coefficient were introduced to determine inequality existence among sampled districts.

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Model Specification

This study proved to be novel as it combines the *travel cost method* of evaluation along with *regression* and the adoption of the *Coefficient of Variation* as a measure of inequality in income in the study areas.

Travel Cost Method

Travel cost (TC) methods depends on information about the amount of money and time people expend to access the site for fuel wood and a value is inferred for the site. This study considered the Individual Travel Cost Method (ITCM) as the preferred method used by environmental economists for evaluation of fuel wood compared with the Zonal Travel Cost Method (ZTCM). The individual travel cost method captures the consumer surplus of households (welfare measurement). The study considered the travel cost method for the fuel wood commercialization study because, fuel wood has a used value (See Arcadio, 2005). The estimated model was the ordinary least regression as favoured by many researchers (Creel and Loomis, 1990; Prayaga et al, 2004 and Twerefou and Ababio, 2012).

Empirical Model

Following Twerefou and Ababio (2012), a regression was adapted and modified to observe the impacts of the control variables on the dependent variable. This model is the main trip generation function used for the study. The empirical model therefore takes the form:

$$\mathbf{V} = \beta_0+\beta_1 TC+\beta_2 Y+\beta_3 AG+\beta_4 SX+\beta_5 ED+\beta_6 ImD+\beta_7 MR+\beta_8 Alt+ \varepsilon \text{ -------- (1)}$$

Where: V= number of visits for fuelwood commercialization by each individual i (Household head), β_0= intercept of the trip generation function, **TC**= travel cost for fuelwood commercialization by each individual household head (expressed in cedis per visit), **Y** = income from fuel wood commercialization by each individual household head (expressed in cedis) , **AG** = age of each individual household head (expressed in years), ***SX*** = is the sex of each individual household head (express as: 1=male, 2= female), **ED**= highest level of formal education by each individual household head (years), ***ImD*** = is the highest number of immediate dependents by each individual household head, ***MR*** = marital status of each individual household head, **Alt** = Knowledge about existence of alternative site by each individual household head (expressed as a dummy: 1 for knowledge and 0 for otherwise), **ε** = error term, to capture error in the dependent variable; i= 1, 2,….280 household head.

The above model (1) has to work in line with a prior expectations, theory and experience. These offers reliability, objectivity and validity for results of the study. The measurement of the variables are that, all the independent variables in the model should have negative relationship (impact negatively) with the number of visits for fuel wood commercialization with the exception of the sex and marital status of the respondents. The sex and marital status of the respondents may take a positive or negative dimension depending on the motivation. The economic motivation is that, a researcher is able to place a value on forest resources like fuel wood which are often neglected in developing countries account for GDP as a measure of economic prosperity.

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Coefficient of Variation and GINI Coefficient

The Coefficient of variation is the ratio between the standard deviation and the mean and thus represented in a percentage form. The Gini coefficient is a lump up numerical estimates of inequality from a point of zero (0) (perfect equality) to one (1) (perfect inequality). The idea behind these measures is to provide consistency of the observations within a sample districts and participation in fuel wood commercialization to guarantee consistency. Both the coefficient of variation and the Gini Coefficient are measures of inequality (See Todaro and Smith, 2011 Pp. 210).

They are good approximation of inequality as they satisfied the four (4) major criteria: anonymity, scale of independence, population dependence, and transfer principle (Todaro and Smith, 2011). The anonymity principle refers to measure of inequality without regard to who has the higher income. Scale of dependence measure explains that, inequality should be based on how income of the economy is measured or the manner in which is income in the economy. Population independence considers measurement of inequality as not limited to only the number of recipients and the transfer principle referred to as "Pigou-Dalton Principle" espoused that, ceteris paribus, in relation to other incomes, if we transfer some amount of income from the rich person (not so much to make him worse off) to a poor person, the emanating new income distribution is more equal (Pareto optimal).

The above principles reinforce the wider acceptability of the coefficient of variance and Gini coefficients to explain the variations among sampled districts, household's income and participation for fuel wood commercialization in the Northern Region of Ghana.

The study used the Lorenz curve as a basic approximation of inequality among the participated sampled districts household heads earned income from fuel wood commercialization.

$$\frac{standard\ deviation}{Mean}100=CV$$

For analysis, a lesser coefficient of variation for one district compared with higher coefficient of variation of another district represent some amount of inequality in terms of the individual household heads involved in commercialization of fuel wood in the Northern Region of Ghana.

Gini coefficient

The Gladman and Muchapondwa (2013) Gini coefficient was adapted to approximate how each sampled district was represented.

$$\boldsymbol{G = \frac{2cov\ (y,ry)}{ny^{-}}} \text{ ..... (2)}$$

Where cov (y,r_y) is the covariance in relation to income (y) and ranks of all individual household heads according to income ranking (r_y) from the poorest individual (rank = 1) to the richest (ranks =N) . N is the total number of individuals and y^{-} been the mean income.

RESULTS AND DISCUSSIONS

Summary statistics of household heads on fuel wood commercialization is explained. This study used a structured questionnaire to obtain information from household heads. Therefore,

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the axiom is that, information provided by the head is a true reflection of the household. A household here according to this study refer to a person or group of persons who eat from the same pot and dwell under the care of a head. Table 1 provides the characteristics of the household heads in the sampled communities.

Table 1: Descriptive Statistics for Sampled

Households (Households Characteristics)

Variable **N**= 280	**Frequency**	**Percent**
Sex:		
Male	88	31.4}
Female	142	68.6}
Age:		
20yrs-34yrs	21	7.5
35yrs-44yrs	82	29.3
45yrs-54yrs	126	45.0
55yrs +	51	18.20
Immediate Dependents:		
1	21	7.5
2	21	7.5
3	57	20.4
4	63	22.5
5	57	20.4
6 above	61	21.8
Marital Status:		
Single	21	7.5
Married	202	72.1
Divorced/Separated	21	7.5
Widow/Widower	36	12.9
Highest Level of Formal Education:	232	82.9
None	29	10.4
Middle/JSS	19	6.8
SSS		
Employment Status:		
Full time	187	66.8
Part time	49	17.5
Seasonal	44	15.7

Source: Field Survey, 2015

Table 1 depicts information on households' characteristics which are: sex, age, immediate dependents, marital status, highest level of formal education and employment status along with their frequencies, percentage, mean, and standard deviation. The results has shown that,

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88(31.4%) of the results were males and 192(68.6%) were females. The age of the respondents showed that, 126 (45.0%) are in the age 45-54 actively engaged in fuel wood commercialization in the selected districts. Predominantly, 202 (72.1%) of the married had approximately four (4) immediate dependents and this is supported by the GSS (2010) data that, the rural households have high population growth rates. The results evidently also show high number of respondents without formal education 232 (82.9%). Therefore, due to lack of employable skills as many as 187 (66.8%) decided to engaged in fuel wood commercialization as a full time business and few are involved in other part time businesses. In the case of dominance in the fuel wood commercialization business, the results revealed that, women were domination in the business and this result is supported by Tabuti et al (2003) study which opined that, women are dominating in fuel wood business.

Sustainable harvest and Commercialization of Fuel wood

The study implicitly asked a sustainable implication of fuel wood harvest for commercialization to collaborate the literature. The results in Table 2 was a cross tabulation between the type of fuel wood harvested and the main source in which they harvest their fuel wood.

Table 2: Harvesting and Sustainability

		Main source of obtaining fuel wood		Total
		open vegetation	farm gathering	
Type of fuel wood harvested	dead dry trees	167	19	186
	over aged trees	94	0	94
Total		261	19	280

Source: Field Survey, 2015

From the results on table 2, the main source that the sampled households obtained their fuel wood was from open vegetation, 261 (93.2%). The trees they harvested for fuel wood was mainly dead dry trees as shown on the table 186 (66.4%). With these two cross tabulation, there exist a sustainability harvest idea in that, even though, the inhabitants harvested from open vegetation which was obvious from the results, they were mindful to harvest significantly dead dry trees. The study also related that, they also harvested over aged trees, 186 (33.6%) which in terms of regeneration may not have been possible. The results on the table revealed community members do obey the directives of the local authorities not to harvest wet standing trees. The results regarding the implied sustainability harvesting is supported by Manyatsi and Hlophe (2010). Many households perhaps would in future continue to be involved in fuel wood commercialization owing to the fact that, it is an open access resources and not from the few restricted forested areas in the Northern Region. In addition, fuel wood harvested are dead/dry trees and household heads believed that, fuel wood harvested from restricted forested sites is not a major challenge.

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Factors that motivate Household heads to engaged in fuel wood commercialization

The study investigated the major factors which motivated sampled households to engage in fuel wood commercialization as a business entity. Some of the sampled district had no major forest and therefore existence of trees were few. Relying on this, thus triggered the question of motivational factors. The distribution of the responses from the sampled household heads are shown in figure 1.

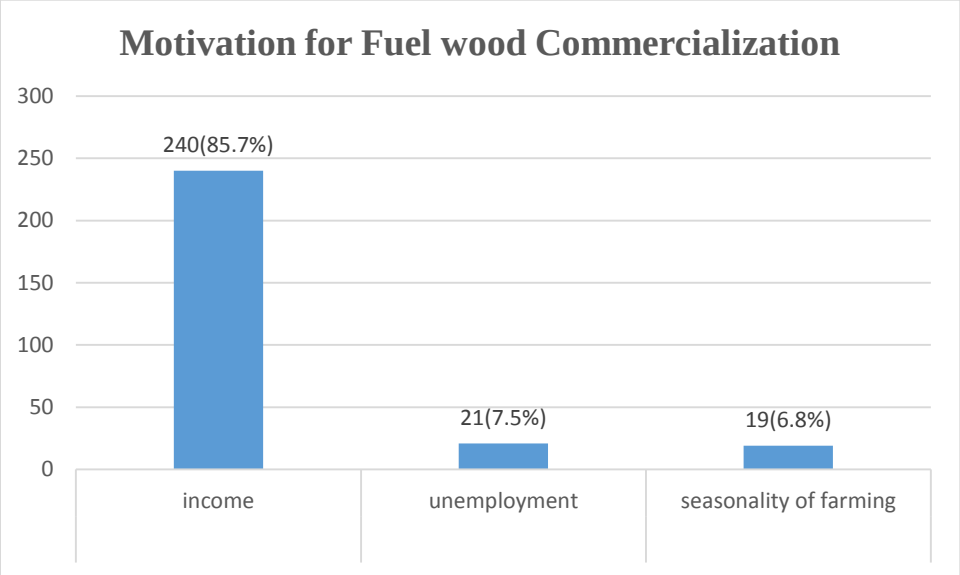

Figure 1: Major factors Motivating Households Decision to engage in Fuel wood Commercialization

Source: Field Survey, 2015

The results from Figure 1 showed that, 240 (85.7%) of the respondents said that, income generation has been the reason for them engaging in fuel wood commercialization. Even though, they had other non-fuel wood occupations and the income from fuel wood commercialization is higher than other sources. Whereas 21(7.5%) said unemployment was a factor which motivated them to engaged in fuel wood commercialization, and remaining 19 (6.8%) attributed their involvement in the business to seasonal nature of faming activities. This result confirms the Ghana Statistical Service data (2010) and the GLSS 6 data (See GLSS 6, 2014).

As Tabuti et al (2003) noted, because households considered fuel wood to be available so they easily involved in commercial activity related to fuel wood. The households however, have preferences regarding the fuel wood they harvest for commercial purposes. The implication of the figure 1 is that, household heads go into fuel wood commercialization due to income.

Composition of sampled Households Income

Respondents were asked to provide information regarding the main sources of their incomes. This was to provide explanation regarding the composition of incomes from the sampled districts. The responses are shown in Table 3.

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Table 3: Source of Income for households

	Frequency	Percent
fuel wood	156	55.7
charcoal	60	21.4
hunting	31	11.1
Forest plant foods	33	11.8
Total	280	100.0

Source: Field Survey, 2015

Sources of income for households as shown in Table 3, proved that, majority of the sampled households 156 (55.7%) obtained their income from fuel wood commercialization and the least been proceeds from hunting. The results are further supported by empirical evidence that, households do not only depend on fuel wood but other environmental resources for survival (see Gladman and Muchapondwa, 2013; Kabubo-Mariara and Gachoki, 2008). This explained the diversification of forest income (Vedeld et al., 2004; Angelsen and Wunder, 2003 cited in Kabubo-Mariara, 2008).

Determinants of the most preferred fuel wood by household heads and income inequality among districts.

(a) The study intended to find out which fuel wood species was preferred by sampled households as a fuel wood for commercial purposes and the results are shown in the Table 4.

Table 4: Preferred Fuel wood Harvested

Tree Specie	Frequency	Percent
Nee(Pterocarpus erinaceus)	25	8.9
Korli (Terminalia avicennioides)	30	10.7
Kpariga(Heteranthera callifolia)	42	15
Sampeega(Crossopteryx febrifuga)	21	7.5
Langena(Prospis africana)	34	12.1
Tanga(Vitellaria paradoxa)	113	40.4
other	15	5.4
Total	**280**	**100**

Source: Field Survey, 2015

As one of the objective of the study was to investigate which of the tree species were preferred by sampled households. This objective was necessitated to draw conclusion regarding SADA Afforestation programme. The results showed that "Tanga", popular among the sampled locality, was the most preferred tree species for fuel wood with 113 (40.4%). This particular tree, until recently, has been a fruit tree which has not been cultivated. It was often regarded as a "wild" plant in the Northern Region. Currently, the interest of policymakers in making this

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tree which bores the shear nut an export commodity is worrying. The reasons is that, this particular tree has a long gestation period and yet it is regarded as a preferred tree for fuel wood. As Njiti and Kemcha (2007) explained that, household heads preferred fuel wood are exploited when they have good attribute of good flame and gradual burn. This was explained as good reason for increase consumer demand for a particular species.

(b) Income inequality and variation of income within the districts

The study investigated the participation rates and the income earned from fuel wood commercialization among sampled household heads in the districts. The aim of this investigation was to make an inference regarding different rate of fuel wood commercialization and the benefit of fuel wood commercialization to household heads in each specific district.

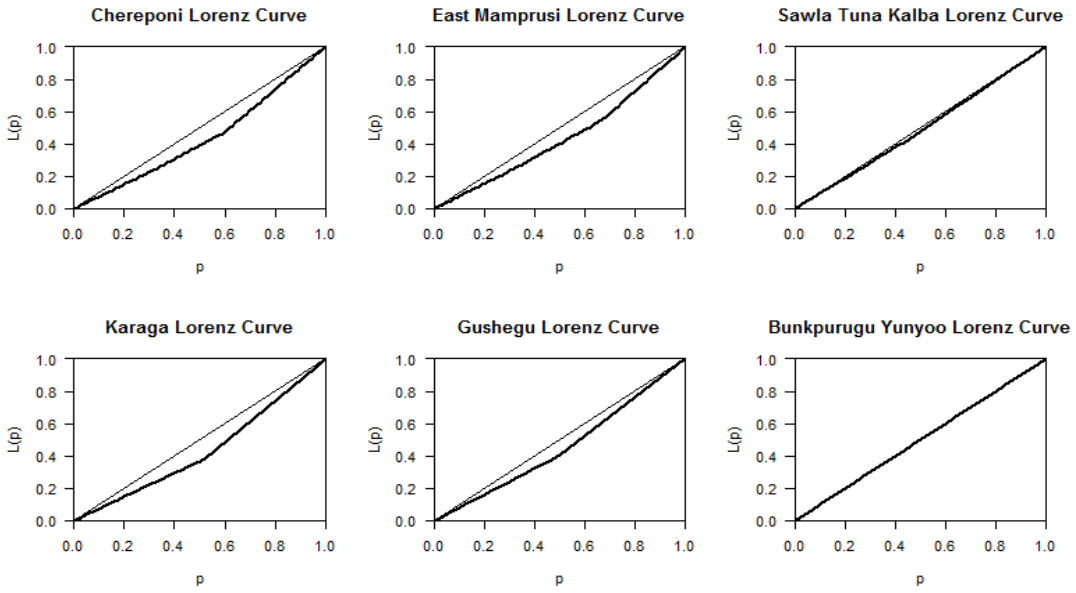

Figure 2: **Inequality among sampled districts' on fuel wood commercialization**

Source: Field Survey, 2015

Table 5: Gini Coefficient and Coefficients of Variation of Sampled Districts

	districts	gini	coef.var
1	chereponi	0.133582	0.260527
2	east_mamprusi	0.129893	0.258942
3	sawla_Tuna_kalba	0.023528	0.047499
4	karaga	0.137972	0.27629
5	gushegu	0.096852	0.193705
6	bunkpurugu_yunyoo	0	0

Source: Field Survey, 2015

The study investigated the degree to which income inequality existed among sampled districts'. The results are displayed using the Lorenz curves and the table 5 (Gini coefficients and Coefficient of variation). The table 5, which the Gini coefficients and Coefficient of variation lump all households income in sampled districts into one value and the Lorenz curves are

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produced from the same data to approximate inequality dominance among sampled districts. The majority of the sampled districts showed inequality within a district as regarding income earned from fuel wood commercialization. It is Bunkpurugu Yunyoo district which happens to have perfect equality on income distribution on participation for fuel wood commercialization. This is followed by Sawla Tuna Kalba district with marginal inequality. The study demonstrated that, households are able improve their wellbeing from fuel wood commercialization despite the inequality among sampled households in the district. What is interesting is that, studies on income inequality in Ghana, have not so much integrated the important role fuel wood income and thus left out of policy. Gladman and Muchapondwa (2013) collaborated this study when, they opined that, environmental resource use impacts on inequality reduction in income and yet has not been much appreciated by policymakers.

Fuelwood commercialization and households' welfare using the travel cost method.

Forest has played immeasurable role in sustaining world population. Because of this important role forest play to humankind, a lot of people found life in it (See MEA, 2005). In exploring the linkage between fuel wood commercialization and household heads welfare, and thus answers the hypothesis that travel cost by household heads has no effect on the number of visit for fuel wood the study used the travel cost method.

Table 6: Derivation of Individual Visit

Average Travel Distance (KM)	Frequency	Relative Frequency (%)	Target Population	Visit Per Year	Travel Cost Per Visit	Individual Visit
1	**2**	**3**	**4**	**5**	**6**	**7**
1	7	2.50	25	133	2.30	5.30
3	36	12.86	127	900	3.00	7.10
7	111	39.64	393	7881	3.70	20.10
10	88	31.43	311	3872	4.30	12.50
12	29	10.36	103	2639	4.80	25.60
15	9	3.21	32	270	5.30	8.40
Total	**280**	**100.00**	**991.027**	**15,695**		

***Individual Visitation =** visits per year divided by population in each category

***Target Population size** = Population of household heads in the sampled districts (991.027).

Source: Field Survey, 2015

The derivation of the individual visitation from table 6 above stemmed from visits per year over the population in each category who traveled for fuel wood. The derivation is supposed to offer the insight into how sampled individuals made visit for fuel wood when access to the forested sites are free. As the travel cost to the site increases, the study observed a reduction in the number of visit for fuel wood, even though there exist a mixed results.

The pattern as observed above is responding to the law of demand that, the higher the price, the lower the quantity demand, and holding other factors constant (the other computational

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processes are obtained in the appendices). The results of expected visit from various scenario are shown in Tables 7-9.

Table 7: Expected Visit I (Cost of Access GH ₵ 5.30)

Average Travel Distance (KM)	Target Population	Travel Cost +Cost of Access of GH ₵ 5.30	Visit Rate	Expected Visit with cost of access introduction
			4	5
1	2	3		
1	25	7.60	0	0
3	127	8.30	1.80	229
7	393	9.00	14.80	5816
10	311	9.60	7.20	2239
12	103	10.10	20.30	2091
15	32	10.60	3.10	99
Total	**991.027**			**10,474**

Source: Field Survey, 2015

Table 8: Expected Visit II (Cost of Access GH ₵ 10.00)

Average Travel Distance (KM)	Target Population	Travel Cost +Cost of Access of GH ₵ 10.00	Visit Rate	Expected Visit with cost of access introduction
			4	5
1	2	3		
1	25	12.30	0	0
3	127	13.00	0	0
7	393	13.70	10.10	3969
10	311	14.30	2.50	778
12	103	14.80	15.60	1607
15	32	15.30	0	0
Total	**991.027**			**6,354**

Source: Field Survey, 2015

Table 9: Expected Visit III (Cost of Access GH ₵ 25.00)

Average Travel Distance (KM)	Target Population	Travel Cost +Cost of Access of GH ₵ 10.00	Visit Rate	Expected Visit with cost of access introduction
1	2	3	4	5
1	25	27.30	0	0
3	127	28.00	0	0
7	393	28.70	0	0
10	311	29.30	0	0
12	103	29.80	0.60	62

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15	32	30.30	0	0
Total	**991.027**			**62**

Source: Field Survey, 2015

The study invoked the ceteris paribus assumption on Table 6 when the access cost is added to the travel cost to access fuel for commercialization, there are a certain amount of tolerance level of which expected visit for fuel wood will fall drastically. These are shown on Table 7, 8 and 9. When an access cost of **GH ₵ 5.30**, **GH ₵ 10.00** and **GH ₵ 25.00** were introduced respectively, expected yearly visit for fuel wood fell from **10,474, 6,354** and **62** respectively. The results Tables (7,8 and 9) depicted the downward sloping demand curve. These results have been the expectations of theory and experience in practice. This invariable is shown on Table 10. Access cost checks over exploitation of open access resources and even where the travel cost to the forested site are low.

Table 10: Aggregate Visits (All Cost of Access)

Average Travel Distance (KM)	**Cost of Access of GH ₵ 0.00**	**Cost of Access of GH ₵ 5.30**	**Cost of Access of GH ₵ 10.00**	**Cost of Access of GH ₵ 25.00**
1	**2**	**3**	**4**	**5**
1	133	0	0	0
3	900	229	0	0
7	7881	5816	3969	0
10	3872	2239	778	0
12	2639	2091	1609	62
15	270	99	0	0
Total Visit	**15,695**	**10,474**	**6,354**	**62**

Source: Field Survey, 2015

Aggregate visit results from Table 10 demonstrated how changes in access cost to forested sites will impact number of visit for fuel wood and implicitly on households' income. As costs of access increased, the number of visits for fuel wood reduced drastically as portrayed on the table. This expected number of visits are then used to plot the demand curve to estimate households' welfare for fuel wood commercialization in the Northern Region.

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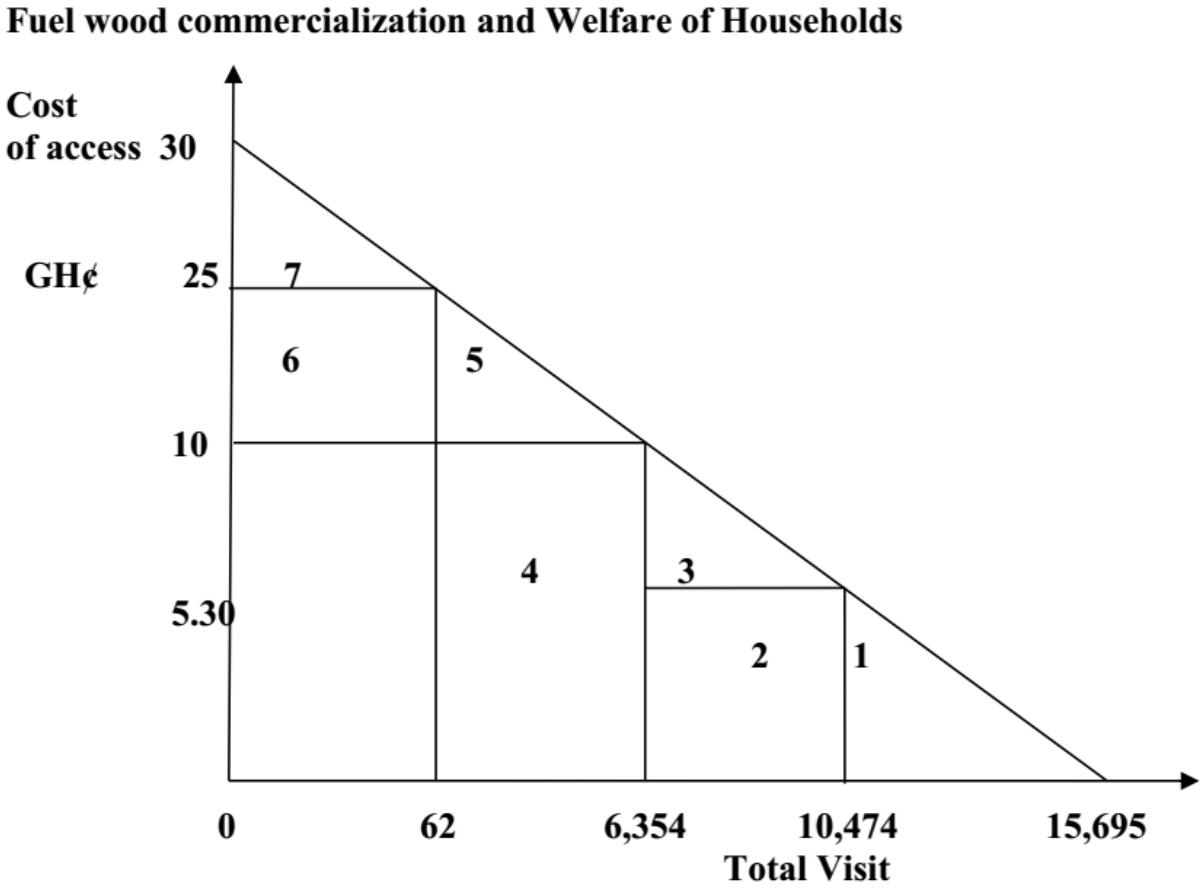

Figure 3: Demand Curve for Fuel wood Commercialization of Households

Source: Field Survey, 2015

The demand curve for fuel wood commercialization expresses the various total visits and their access costs. The figure slopes downward from left to right, signaling that, an increase in access cost leads to decrease to the number of visit for fuel wood. The study estimated the households' welfare (total consumer surplus) by integrating under the demand curve (Mehmet and Mustapha, 2006) or simply one divided by the coefficient of the travel cost (Twerefou and Ababio, 2012).

The study computed the household heads welfare (total consumer surplus) to be **GH₵ 142,985.** The value computed is the total welfare of all sampled households who engaged in fuel wood commercialization. This becomes an implied opportunity cost for households in which they must sacrifice something to obtain this value. The implication here is that, if there is a government policy or an externality which makes this value (**GH₵ 142,985**) unavailable, the household heads will be worst off by that amount of consumer surplus.

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TABLE 11. MODEL'S REGRESSION RESULT

VARIABLES	PARAMETER VALUES (COEFFICIENTS)	STANDARD ERRORS	P-VALUES (Sig.)
(Constant)	1.956	0.494	0.000
Travel cost to harvest fuel wood	-0.410	0.066	0.000
Level of yearly income of respondents	0.306	0.036	0.000
Age of respondents	-0.440	0.045	0.000
Sex of respondents	1.027	0.118	0.000
Highest level of formal education	-1.758	0.104	0.000
Number of immediate dependents	0.320	0.029	0.000
Marital status of respondents	-0.637	0.057	0.000
Knowledge of substitute site	-0.885	0.149	0.000
R Square	95%		
Adjusted R Square	94%		
Durbin-Watson	1.883		

a. **Dependent Variable**: number of visitation for fuel wood

****significant at 5%**

Source: Field Survey, 2015

V = 1.956-0.410***TC***+0.306 ***Y***-0.440***AG***+1.027 ***SX*** -1.758***ED*** +0.320 ***ImD*** -0.637***MR*** -0.885***Alt***

The model's result as shown in the table 11 provide the coefficients, the standard error and the P-values. The p-values were all significant and imply the robustness of the model. The study postulated the directions of all the variables with the exception of sex of respondents and marital status. The results revealed that, travel cost (-0.410) to the forested sites negatively related to the number of visits for fuel wood. In that, increased in travel cost will deter households from increasing their visit rates. In terms of fuel wood demand theory, the expectation is that, as households' income increases, they tend to reduce fuel wood demand, however, in the case of fuel wood commercialization, an increase in income serves as a motivation for households to continue the harvest process (holding other factors constant). This income result (0.306) from the table showed a positive relationship with the number of visits for fuel wood. The result of the age of the respondent (-0.440) was negative and this was expected, because as an individual ages, the strength reduces and since the harvest require the physical strength, the said individual will reduce the number of visit. The sex of the respondent (1.027) from the study was positive. The data coding process adopted, male =1 and female = 2, in addition, the results showed women were dominating in fuel wood commercialization in

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the sampled districts. Therefore, the tendency for women according to data to be involved in fuel wood commercialization is very high.

The highest level of education (-1.758) had a negative relationship with the number of visits for fuel wood. The interpretation is that, educated people among the sampled households perhaps tend to have more knowledge about forest conservation and preservation and therefore will reduce their number of visit for fuel wood. In addition, higher education provide potential for increase in income and therefore less dependence on forest income. The higher the number of immediate dependents (0.320) the more likely would be an increase in the number of visits for fuel wood. This indeed showed there is a positive correlation. Both the marital status and the knowledge of availability of substitute were negative; -0.637 and -0.885 respectively. The coefficient was negative. This could be explained that, married people have limitations as to the number of times they could visit forested site because of other family demands. The result of the knowledge of availability of alternative site was also negative. Empirically, Twerefou and Ababio (2012) study supported the results of all the dependents variables with the exception of the number of immediate dependents, even though the application of the methodology differs.

Hypothesis

H_o: Travel cost by individual (household head) has no effect on the number of visit for fuel wood in the Northern Region.

H_1: Travel cost by individual (household head) has effect on the number of visit for fuel wood in the Northern Region.

The study revealed that, increased in travel cost which includes the opportunity cost of time has a negative impact on the number of visits for fuel wood at a 5% error level and ultimately the livelihood of sampled household heads. At the same time, an increase in cost of access for fuel wood impacted negatively on fuel wood commercialization. From the aforementioned intuition, and the hypothesis stated, the study therefore reject the null hypothesis which stated that, travel cost has no effect on the number of visits for fuel wood. In addition, the coefficient of the travel cost is negative and therefore, the study rejected the null hypothesis and accepted the alternative hypothesis.

CONTRIBUTION OF STUDY

This particular study has been a novel in environmental and development economics literature and an original contribution to the travel cost methodology. This contribution emanated from the fact that, in empirical literature, the estimation of travel cost is most often by regression estimation, however, this study has provided a step- by- step data disaggregation process to estimate the travel cost method. In addition, the study obtained a construct which is based on the data to explain the marketing processes of fuel wood. Lastly, the study combined three approaches (travel cost method, Gini coefficient and the Coefficient of variation) for this particular study. The study revealed the following channel of fuel wood commercialization marketing and supply.

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Fuelwood Commercialization Marketing and Supply Channel

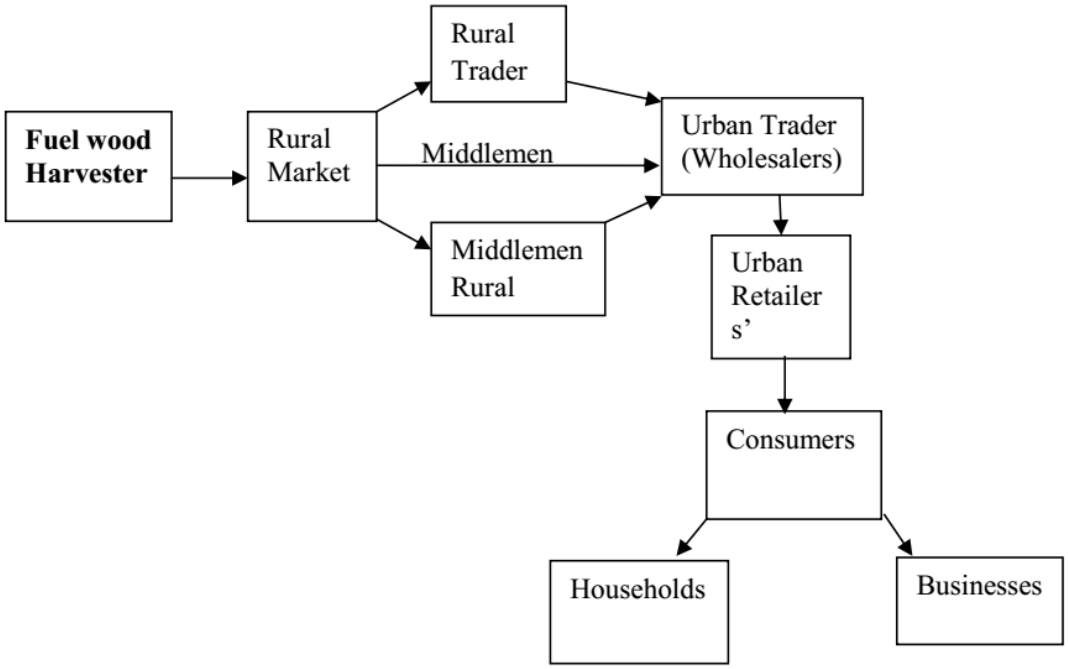

Figure 4: Author's Construct - Fuelwood Commercialization Processes (Marketing Channel)

Source: Field Survey, 2015

CONCLUSIONS AND POLICY RECOMMENDATIONS

This paper studied fuelwood commercialization and households' welfare in the Northern Region of Ghana. The study sampled six (6) districts and elicited information from household heads. The intent of the paper was to investigate benefit from fuelwood commercialization from the perspective of the travel cost method.

The analysis of the results proved sustainable harvest of fuelwood for commercialization as 167(60%) of the respondents harvested dead/dry tree as fuelwood and not wet standing trees. This harvest of dead/dry trees is done instead of wet standing trees because of the directive from the community leaders. The results of the study further revealed that, 240 (85.7%) were motivated for fuelwood commercialization because of income and harvesters earn some amount of income.

Another interesting observation is that, household heads diversify their portfolio in terms of income seeking and dependable on forested resources, however, fuel wood has been a major contributor to the incomes of households. In addition, 'Tanga' (Vitellaria paradoxa) is the most preferred fuelwood specie among the respondents. This particular tree species is the shear tree which has other economic benefits to people.

The study linked fuelwood commercialization and households' welfare using the travel cost method. The results showed that, an increase in travel cost reduces the number of visits for fuelwood and this supports the alternative hypothesis of the study. The study showed that, the

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total consumer surplus (household heads welfare) was GH¢142,985 annually. Furthermore, the regression results for the study generally supported a prior expectation.

The major conclusion drawn from the study is that, fuelwood commercialization at the study areas contributed significantly to poverty reduction and welfare enhancement and a major safety net; and that, the activity is sustainability and environmental friendly.

From policy recommendations, the findings does rely on the fact that, fuelwood commercialization can potential move inhabitants of the Northern Region above the poverty line as shown in the data. A policy intervention aimed at deliberate cultivation of forest for fuelwood either from government, non-governmental organization or international donors would better the lives of the people.

The accessed lands in the areas were mainly open vegetation, and harvesters did not need any training to harvest, therefore, forest management and conservation strategies must be given a serious attention within these areas by the forest commissions. Finally, policies put in place to prevent or limit fuel wood commercialization should be done away, as the study has revealed that, their activity do not cause any environmental degradations.

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APPENDIX A

A COMPUTATION OF VISIT PER YEAR, TOTAL TRAVEL COST AND THE TOTAL CONSUMER SURPLUS

HOW DATA ANALYSIS WAS UNDERTAKEN

COMPUTATION OF VISITS PER YEAR

Average Travel/ Distance	Visits Options/	Frequencies/	Visits per Year	/Individual Visit
1	312	7×19=	133	5.32/5.30
3	260	36×25=	900	7.09/7.10
7	208	111×71=	7881	20.05 /20.10
10	156	88×44=	3872	12.45/12.50
12	104	29×91=	2639	25.62/25.60
15	52	9×30=	270	8.44/8.40

***Visit per year (zero access cost) =** inverse of the visitation options (frequency) against the average travel distance (frequency)

COMPUTATION OF TOTAL TRAVEL COST

Total travel cost = initial travel cost + opportunity cost

Where: initial travel cost = lorry fares

Opportunity cost – 1/3 of minimum wage (April, 2015)

Distance traveled	fare	one- third minimum wage	travel cost + opp = ttc
1	0	1/3 x 7 = 2.33	0+2.33 = 2.30
3	0.70	1/3 x 7 = 2.33	0.70 + 2.33 = 3.03
7	1.40	1/3 x 7 = 2.33	1.40 + 2.33 = 3.73
10	2.00	1/3 x 7 = 2.33	2.0 + 2.33 = 4.33
12	2.50	1/3 x 7 = 2.33	2.50 + 2.33 = 4.83
15	3.0	1/3 x 7 = 2.33	3.0 + 2.33 = 5.33

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TOTAL CONSUMER SURPLUS COMPUTATION (HOUSEHOLDS WELFARE)

1. Triangle ($\frac{1}{2} base \times height$) 0.5(5,221×5.30)=13,836
2. Rectangle (Length×Breath) (4120×5.30) = 21,836
3. Triangle ($\frac{1}{2} base \times height$) 0.5(4120×5.30)=10,918
4. Rectangle (Length×Breath) (6292×10) = 62,920
5. Triangle ($\frac{1}{2} base \times height$) 0.5(6292×10)= 31,460
6. Rectangle (Length×Breath) (62×25)= 1,550
7. Triangle ($\frac{1}{2} base \times height$) 0.5(62×15) = 465

TOTAL CONSUMER SURPLUS (Households Welfare) = **142,985**

Relative Frequency $= \frac{frequency}{samplesize} \times 100$

Population in each Average Travel Distance $= \mathrm{Re} lativefrequency \times Population$

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APPENDIX B

COMPUTATION OF TARGET POPULATION AND SAMPLE SIZE

1. Chereponi 2.2% of 7,116 = 156.552
2. East Manprusi 1.7% of 13,895 = 236.215
3. Suo-Tuna-Kalba 1.6% of 14,906 = 238.496
4. Bunkpurugu-Yunyoo 0.8% of 117,621 = 140.968
5. Karaga 1.4% of 7,664 = 107.296
6. Gushiegu 1.0% of 11,150 = 111.50

991.027

Formula: $u = \frac{N}{1+N(x^2)}$ where u = sample size & (5%) is the error margin and the conference interval is 95%.

$$U = \frac{991.027}{[1+991.027\ (0.5)^2]}$$

$$U = \frac{991.027}{[1+991.027\ (0.0025)]}$$

$$U = \frac{991.027}{3.4775675} = 284.977$$

$$= 285$$

Source: Ghana Statistical Service (2010): Figure 1: Map of Northern Region

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