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Shea butter and its processing impacts on the environment in the Tamale Metropolis of Ghana

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Abstract

Shea tree is an indigenous and exclusive asset in West and Central Africa and particularly wide spread in the Northern part of Ghana. This study examined the effects of shea butter processing on the environment in the Tamale Metropolis and also analyzes the efficiency of resources used in shea butter processing for improved and traditional method of processing. Interviews, focus group discussions and field observation were used for the study with 126 respondents. Analytical tools used include descriptive statistics comprising charts; tables and frequency distribution with the use of SPPSS for the data analysis. The findings are that the semi-mechanized method is more suitable in terms of less and efficient resource maximization than the traditional method. The disposed slur inhibits plant growth and contributes to changing the soil structure. The results of the probit model reveal that labor ($t=0.241$, $p<0.01$), water ($t=0.189$, $p<0.01$), fuel wood ($t=0.061$, $p<0.01$) and processing experience ($t= 0.152$, $p<0.01$) showed a positive significant relationship with the efficiency of resources used for the processing methods. The sign for each coefficient is consistent with the expectation; that is, the probability of using more resources increases cost of processing and reduces efficiency of the processing methods.

Keywords: Shea butter, Environment, Processing, Resources, Methods, Tamale and Ghana

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1. Introduction

The shea tree, *Vitellaria paradoxa*, has a history known and documented in the Western world and reference is sometimes made to the days of Mungo Park, the British explorer who first described the tree from his journeys in West Africa in the 18th century. The tree is considered a valuable asset in many parts of Africa where it can be found because of its high yielding edible oil for domestic use and products for cosmetic and pharmaceutical uses. It is important for the livelihoods of the rural population as it has been for over centuries (Lovett and Haq, 2000). Almost every part of the tree has its use, for example: the fruit is eaten and the leaves are used as fodder and serve as an ingredient for making alkaline and paint (Lovett and Haq, 2000). When the leaves are put in water, it forms a frothy opalescent liquid, which is used to bath a patient. The shea tree grows well in 19 countries across the African continent, namely Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Ethiopia, Ghana, Guinea Bissau, Côte d'Ivoire, Mali, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Togo, Uganda, Democratic Republic of the Congo and Guinea. Seven West African countries, Ghana, Burkina Faso, Benin, Cote D'Ivoire, Nigeria, Mali and Togo, produce about 500,000 tons of shea nuts, of which an estimated 270,000 tons are exported as raw nuts (Addaquay, 2004).

Ghana especially is the leading exporter in the region, which produces about 55,000 tons of shea nut and exports about 40,000 tons per year (Addaquay, 2004). The commodity is exported to France, Great Britain, the Netherlands, Denmark, North America and Japan (Elias and Carney, 2007). In these countries it is processed into a wide range of food products including chocolate and it is also becoming more popular in the cosmetic industry (Schreckenberg, 2000). The shea tree spreads over almost the entire area of Northern Ghana, over 77,670 square kilometers with West Dagomba, South Mamprusi, West Gonja, Lawra, Tumu, Wa and Nanumba with East Gonja having the densest stands (CRIG, 2002). There is sparse shea tree cover found in Brong-Ahafo, Ashanti, and the Eastern and Volta regions of the country (CRIG, 2002).

In northern Ghana in general and the Tamale Metropolis in particular, many women process shea butter as their main source of income and in recognition of this a number of stakeholders including the Metropolitan, Municipal and District Assemblies, Non Governmental Organizations, the National Board for Small Scale Industries and other private businesses have taken keen interest in the sector culminating in the provision of resources to support the industry. As part of efforts to support the economic empowerment of women in general and shea butter processors in particular, in 2008, the Japanese government provided a grant of 86,000 US dollars to two women shea butter processing groups in Walewale in the West Mamprusi District and Sagnarigu, a suburb of Tamale (Africa 2000 Network, 2009). The grant was to help establish shea butter extraction centres in these two communities. Also in 2008, the United Nations Development Fund (UNDF) approved an amount of 246,000 US dollars for projects expansion for the women processing groups in these same communities (Africa 2000 Network, 2009).

The shea tree produces a lot of fruits which when ripen fall under their own weight and are gathered by women, children and some men from April to August of every year. The fruit pulp is nutritious and a very important source of calories, vitamins and minerals and an important source of food for many organisms including birds and bats. In northern Ghana, the fruits contribute to food security, particularly for the rural

poor, especially since their ripening coincides with the lean season of food production. The fruit of the shea tree has a seed (nut) and in this seed is a kernel which is dried and stored for processing into shea butter.

Processing of shea butter is a way of life for many women in Northern Ghana and the Tamale Metropolis in particular. While many of these women still use the traditional shea butter processing method they leant from their elders' years ago, others think the method involves lengthy, arduous processes requiring large quantities of fuel wood and water which are often carried from long distances. The large demand for labour, water and fuel wood by the traditional method of shea butter processing and a possible environmental effects from large and continues use of fuel wood have motivated many processors to acquire skills in alternative processing method perceived to use less of these resources. The concerns for the high labour requirement in the traditional method of shea butter production and the use of large amounts of water and fuel wood has led to the evolution of a second method of production at the village level in some areas. This method is semi mechanized with a nut crusher, an improved roaster, a kneader or a hydraulic screw press introduced to reduce the drudgery associated with the traditional manual process of shea butter production.

The semi mechanized method of shea butter processing makes a good use of a crusher taking the place of the mortar and pestle in breaking the kernel into tiny units for roasting. The semi mechanized method of shea butter processing has also introduced an improved technology for roasting the kernel after it has been broken into tiny pieces. The improved roaster retains the heat in the compartment to roast the kernel at a reduced time, energy use (both fuel wood and human effort) and the processor exposure to the heat generated by the fire. To further reduce time, energy and human effort, the semi mechanized method of processing has introduced another technology called a kneader to convert the milled kernel into an emulsion ready for cooking or heating. This technology has replaced the use of the hand in kneading. The semi mechanized technology according to Addaquay (2004) has led to an improvement in shea butter extraction rate from 20 percent to 35 – 40 percent and production efficiency and product quality. There are also fully mechanized industrial processing plants. These plants use machine pressers, chemical solvents, or a combination of the two, to extract the oil. Although there are a few of this technology in Africa, the vast majority of fully mechanized processing of shea butter occurs in Europe, Asia, and North America (Chalfin, 2004).

Generally, the nuts are purchased in African markets through wholesalers and then exported to overseas processing plants. However, even the smallest amount of shea butter processed in Africa is usually refined further in overseas factories before being used in the international chocolate or cosmetic markets. In 2006 the Stichting Nederlandse Vrijwilligers (SNV) conducted a study to analyze and understand the shea market value chain in a holistic manner, including understanding all the actors, their relationships, motivation, opportunities and constraints to develop appropriate strategies to link the actors in a mutually rewarding manner. The report indicates that more than 600,000 women in Northern Ghana depend on incomes from the sales of shea butter and other shea-related products as a means of their daily sustenance like supplementing the family food budget and meeting medical and educational expenses.

Also, during shea butter processing different types of by-products are generated and are either further used or disposed off and these include waste brown water and waste black sludge. Aside the accumulations

of both solid and liquid waste on the soil, other elements are also generated during the extraction process and these include heat and smoke. Thus, the objective of the study was to examine the efficiency of resources used in Shea butter processing for improved and traditional methods and also to examine the processing and the waste impact on the environment.

2. Materials and methods

The Tamale Metropolis is the administrative capital of the Northern Region of Ghana. The Metropolis is located at the centre of the Northern Region. It shares common boundaries with Savelugu/Nanton District to the north, Tolon/ Kumbungu District to the west, Central Gonja District to the south-west, East Gonja District to the south and Yendi District to the east as shown in Figure 2. It occupies approximately 750 km sq. which is 13% of the total area of the Northern Region (Tamale Metropolitan Assembly Profile, 2006-2009). The Tamale Metropolis has a population of about 371,351 (GSS, 2010). Being the administrative capital of the region and an urban centre, there are several other ethnic groups and languages in the Metropolis. The dominant vegetation is woody savannah with some common tree species the shea trees, Dawadawa and Neem. A large section of the inhabitants are farmers, petty traders and civil servants. The Metropolis is located east of longitude 1^{o} and between latitude 8^{o}N and 11^{o}. Tamale has uni-modal rainfall pattern with a mean annual rainfall of 1,100mm over 95 rainy days which begin later April to early May.

Figure 1. The Study Area (Source: Ghana Districts, 2011)

2.1. Sampling procedure

Multi-stage sampling techniques were adopted to obtain information from respondents. Both probability and non probability sampling techniques were used to gather data for the study. All the five study communities have shea butter processing centres which were stratified into five homogeneous strata. After the stratification, sample proportion was used to allocate sample size to each stratum. A systematic random sampling was used with a sample fraction of total population for the five centres over the sample size (185/126=1.5 approximately 2). With the sampling interval of 2, the list of members in each processing centre was drawn and the second element included for the study starting from the first element when counting. By picking the first respondent, the researcher used the lottery method where respondents were made to pick pieces of folded paper numbering one (1) to the total number of processors in each centre. A mathematical method was used to determine the sample size of 126 from the population of one hundred and eighty five (185) shea butter processors at 5% level of precision and 95% confidence level. The sample size calculation and distribution are shown below: The sample size formula is given by: n=N/1+N (e) 2; Where n= sample size; N= sample frame and e= level of precision. N=185, (e) = 0.05; therefore: n=185/1**+**185(0.05) 2 =126.45, approximated to 126.

Table 1. Sample Size Distribution

Selected Communities	**Number of processors**	**Sample Fraction**	**Adjusted Proportion**
Katariga	32	0.173	22
Kanvili	57	0.308	39
Sagnarigu	41	0.223	28
Vittin	37	0.2	25
Kumbuyili	18	0.097	12
Total	**185**		**126**

Source: Field Survey, 2011

3. Results and discussion

Three methods including the traditional (which involve the use of simple tools like mortar and pistel, big frying pans, basins, buckets and the use of the hand in the entire production process), semi-mechanized (Uses technology to mechanize some of the unit operations of the manual traditional method. A nut crusher, roaster, a kneader or a hydraulic/screw press often times complements the manual process and reduces drudgery of the traditional system) and the full-mechanized methods(which is not use in the study area) of shea butter processing which has been revealed by literature as being used in the processing of shea butter. Automated method or semi-mechanized method of shea butter processing had 108 (86%) of respondents using it. Also, 18 respondents representing 14% were using the manual or traditional method of butter

processing. None of the respondents in the study area covered were using the fully-mechanized methods of shea butter processing (Table 2). This could be attributed to the low level of technology advancement in the shea processing industry in the study area.

Table 2. Processing Methods used at the Study Area

Processing Methods	Frequency	Percent (%)
Traditional	18	14
Semi-Mechanized	108	86
Total	126	100

Source: (Field Survey, 2011)

On the efficiency of the methods used, results of field observation of shea butter processing revealed that the semi mechanized method which is widely used in the study area, consumes less water, fuel wood and labour hours in the extraction process compared to the traditional method. During an extraction process of 25kg of shea kernel, processors used 1.9 head loads of water using the semi mechanized method as against 2.5 head loads to process the same quantity of kernel using the traditional method. A similar work by Swetman et al, (1997) indicates that in processing 25kg of shea kernel, 2.5 head loads of water was used using the semi mechanized method as against 3.0 head loads using the traditional method. With the semi mechanized method, it required 3 hours 22 minutes to process 25 kg of shea kernel and those using the traditional method required 8 hours 5 minutes to process the same quantity of kernel (Table 3). The result means that, the improved processing method offers reduction in processing time which helps the processors. It also helps the processors to reduce and conserve water thereby saving resources which are limited in supply in the study area.

Table 3. Time spent to Process 25kg of butter

Processes	Traditional	Improved Method
	Time Taken/25kg	Time Taken/25kg
Pounding	60 Minutes	2 Minutes
Roasting	50 Minutes	30 Minutes
Milling	25 Minutes	25 Minutes
Kneading	180-240 Minutes	45 Minutes
Rinsing	30 Minutes	20 Minutes
Boiling	80 Minutes	80 Minutes
Total	8 hours, 5 Minutes	3 hours 22 minutes

Source: (Field Survey, 2011)

Table 4. Resources Usage to Process 25kg of butter

Processes	Traditional	Improved Method
	Resources Required	Resources Required
Roasting	Fuel wood (0.4 head loads)	Fuel wood (0.3 head loads)
Kneading	Water (0.5 head loads)	Water (0.4 head loads)
Rinsing	Water (2.0 head loads)	Water (1.5 head loads
Boiling	Fuel wood (0.5 head loads)	Fuel wood (0.5 head loads
Total	2.5 head loads of water and 0.9 head loads of fuel wood	1.9 head loads of water and 0.8 head loads of fuel wood

1 head load= approximately 30kg

Source: (Field Survey, 2011)

The semi-mechanized method was seen as efficient as respondents intimated that the method gives good quality oil, uses less labour, fuel wood and water as compared to the manual or traditional method of processing. The method according to the respondents also generates less smoke and stress and also gives higher volumes of butter. Addaquay (2004) affirms that, technological advancement that is from traditional to semi-mechanized processing has led to an improvement in extraction rate from 20%- 35% and 40% production efficiency and product quality.

All the respondents indicated that the semi-mechanized method is less effective when there is electricity outage because the crusher and kneader use electricity. Other challenges identified by the same respondents for the semi-mechanized method included the cost of electricity bills, cost of maintenance of both the crusher and the kneader and less quality oil if the operator of the kneader is inexperienced. Eighteen (18) respondents representing 14% said it was rather the traditional method which was efficient with the reasons that good quality oil is produced and the method is less costly compared with the semi-mechanized method. Challenges and adverse impacts associated with the method including; more time and labour needed to use the method, consumption of more fuel wood with its implication on deforestation, less volumes of butter is produced per day, generates more smoke and heat because of the different levels of roasting of crushed kernel, boiling of water for kneading and heating of oil. According to the respondents, they easily get tired and stressed using this method. Wider use of fuel wood and charcoal for domestic and commercial purpose in Ghana gratefully contributes to deforestation which affects the country's ability to house a large carbon sink to absorb emissions and store large quantities of carbon for extended periods of time. Fuel wood remains the sole source of domestic fuel for an overwhelming majority of Ghanaians and specifically Tamale. About 90% of households in Ghana rely on traditional biomass (fuel wood and charcoal) as the primary fuel for domestic cooking and other productive activities (UNDP, 2006). Shea butter processing is one of the activities that use so much fuel wood within the Tamale Metropolis which has serious impact on the environment. 110 (87%) of respondents indicated they use fuel wood as the only source of energy for shea butter processing, as shown in Table 5 apart from 13% of gas.

Table 5. Sources of Energy for Shea Processing

Source of Energy	Frequency	Percent (%)
Fuel wood	110	87.3
Charcoal	0	0
Gas	16	12.7
Electricity	0	0

The use of fuel wood by shea butter processors which is supported by Table 5 contributes to the degradation of the forest resources which largely serves as a carbon sinks and livelihoods source for some people of these areas. Yendi and West Mamprusi Districts were the most affected where fuel wood was sourced for shea butter processing in the Metropolis. An interview with Afa Nasiru, a fuel wood supplier in the Metropolis confirmed that fuel wood could not be gotten from the Tamale Metropolis because of urbanization and the depletion of almost all the tree resources. With regard to respondents' exposure to fire, they complained about constant dehydration and respiratory challenges due to indoor smoke pollution.

Shea butter processing at the study area results in the generation of two types of by-products including waste brown water and waste black sludge. The waste brown water is normally disposed off and the waste black sludge is dried in the compound for further use. About 46% of the processors disposed off the waste brown water on the bare land. Continuous disposal of this substance at a particular place according to the Savanna Agricultural Research Institute has elements which changes soil structure and properties and inhibits plants germination and growth. Also, 37% of the respondents disposed off this by-product in refuse dumps and about 18% of the respondents do their disposals in dug outs (Figure 2).

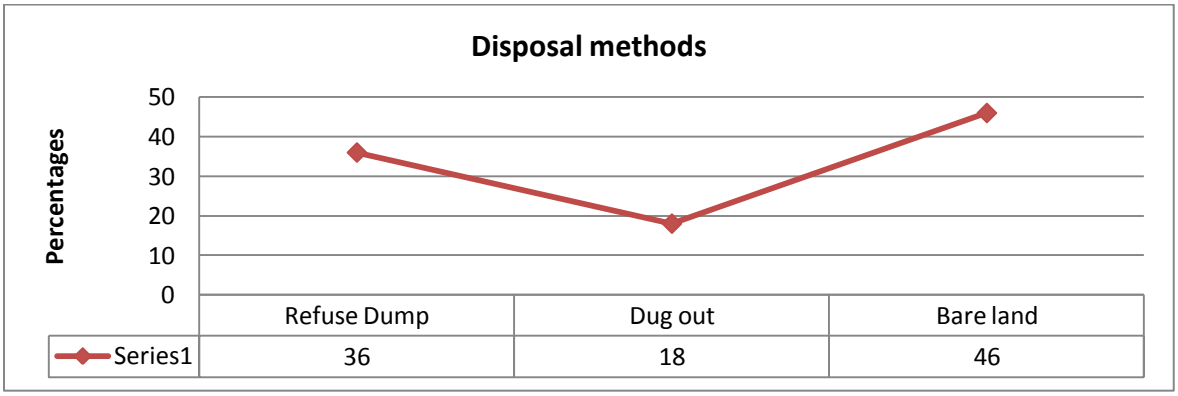

Figure 4. Disposals of Shea by-Product (Source: Field Survey, 2011)

Factors influencing the efficiency of resources used in the processing of the shea butter were indentified using a probit regression model for the analysis. The result of the probit model revealed that labour (t=0.241, p<0.01), Water (t=0.189, p<0.01) Fuel Wood (t=0.061, p<0.01) and processing experience (t= 0.152, p<0.01) showed a positive significant relationship with the efficiency of resources used, whilst time (t= -1.421, p<0.01), showed a significantly negative relationship with efficiency of resources used. The sign for each coefficient is consistent with the expectation; that is, the probability of using more resources increases cost of processing and reduces efficiency of the processing methods. Time is negative (Table 6) which means that when more resources are put in to the processing without much processing experience, several hours are used which affects the butter quality with higher cost. Water shows a significant relationship which means that the use of more water improves the quality of the processed butter though water in the study area is scarce and expensive. Fuel wood (Table 6) also relates significantly as more (fire wood) heat is used, lesser time is spent on one processing cycle but the threat of deforestation is visible in the study area and search for fuel wood is now difficult. Processing experiences also significantly correlates well because the more experience a processor have, the more waste is reduced along the all the stages of the processing and the lesser cost they incur. In all these relationships, the semi mechanize method seem effective in the processing process and use of resource than the traditional ones as discussed earlier, though the mechanize system or method is the best but the cost and higher technology involvement makes acquisition difficult for the processors.

Table 6. Probit regression analysis of factors influencing resource use efficiency

Parameter	Estimate	Std. Error	Z	Sig.
Labour	0.241	0.012	11.721	0
Time	-1.421	0.112	-13.532	0
Water	0.189	0.014	10.253	0
Fuel wood	0.061	0.051	4.21	0
Processing Experience	0.152	0.009	16.642	0.414
Intercept	-4.224	0.641	-6.536	0

4. Conclusion

The study revealed that, the semi-mechanized method of shea butter processing is preferred by majority of processors in the study area because of its efficiency in terms of less use of fuel wood, water and labour hours which is good for the health of the processors and the environment as compared to the traditional method of processing. The adverse impacts of the processing of the shea butter on the environment related with the large volumes of water used in processing which is scarce, changes in the soil structure at disposal

locations, inhibition of plant growth and cutting down of trees which leads to deforestation. The sign for each coefficient is consistent with the expectation; that is, the probability of using more resources increases cost of processing and reduces efficiency of the processing methods thus the traditional and semi mechanized methods.

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