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Editorial Temitope Tunbi Onifade University of Calgary

In this issue, there are three articles dealing with two important areas of sustainability: forestry and consumption. The issue opens with an article on deforestation in Nigeria, a country considered to be one of the places in the world where deforestation is taking place at an unprecedented rate. This is followed by another article also on forestry and Nigeria, although on the use of forest resources as wood rather than the actual extraction of these resources. The last article turns to the issue of sustainable consumption as applicable to a country that highly experiences the implications of global unsustainable practices, Bangladesh.

The first paper analyses deforestation in the Federal Capital Territory of Nigeria. Deforestation generally involves the cutting down of trees in large quantities or human destruction of forests. The objective of the authors is to assess the nature and extent of deforestation in Nigeria's Federal Capital Territory within a period. The authors use images retrieved from Landsat TM to determine the sizes of dense vegetation in the area studied, FAO formulae to calculate the rate of deforestation in the area, and Focus Group Discussion as well as Key Informant Interview to gather qualitative data from key stakeholders and individuals in representative communities within the study area. They find "a dense vegetation of 18.28% in 1987 and 12.69% in 2014 respectively giving a deforestation rate of 0.279% amounting to 374.023ha of dense vegetation loss... and illegal logging, farming activities, developmental projects and poor regulation by the relevant authorities" as among the factors contributing to deforestation. They make some recommendations based on their findings.

The second article is an evaluation of the dimensional stability of *bambusa vulgaris* schrad *ex j*. *c. wendl. culm* along the three orthotropic axes growing in Nigeria. As many forest resources, and bamboo in this case, are unique to specific climatic conditions, the authors examine how their specimen, collected from Ibadan in Nigeria, would behave under set experimental conditions, and the implication of this for its industrial use. They find increasing or decreasing shrinkage across tangential, radial, volumetric, and longitudinal axes of the specimen culm. Based on their findings, they provide conclusions on the significance of tangential, radial, volumetric, and longitudinal shrinkage.

The third and last article is on the need for sustainable consumption in Bangladesh. Using secondary sources, the objective of the author is to generate ideas for sustainable consumption. To achieve this objective, the author defines sustainable consumption, examines the development of global sustainable consumption governance, evaluates the importance and rebound effect of sustainable consumption, investigates the ways of practicing sustainable consumption as well as examples and the accustomed problems, and makes relevant recommendations. The author concludes that sustainable consumption, as a concept, is new in Bangladesh, although, to a certain extent, already practiced consciously or unconsciously.

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ANALYSIS OF DEFORESTATION IN THE FEDERAL CAPITAL TERRITORY, NIGERIA

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Abstract

A detailed analysis of deforestation in the Federal Capital Territory (FCT), Abuja, Nigeria was carried out with the aim of assessing the nature and extent of deforestation in the territory between 1987 and 2014 using satellite images of 1987 and 2014. The images were retrieved using Landsat TM at 1000m resolution and subjected to NDVI to ascertain the actual sizes of dense vegetation in the area. The FAO formula, $Q = (A_2 / A_1)^{1/(t2 - t1)} - 1$ was used to calculate the deforestation rate while Focus Group Discussion (FGD) and Key Informant Interview (KII) were adopted to retrieve qualitative data from women, key stakeholders and residents in some selected communities of the FCT. The results of the survey show a dense vegetation of 18.28% in 1987 and 12.69% in 2014 respectively giving a deforestation rate of 0.279% amounting to 374.023ha of dense vegetation loss. The findings also show that illegal logging, farming activities, developmental projects and poor regulation by the relevant authorities are some of the factors that contribute to deforestation. It therefore concluded that the activities of residents, government and poor regulation contribute to the high rate of deforestation and other forms of degradation of the forests. Recommendations were made based on the findings of the study.

Keywords: Deforestation, Vegetation, Federal Capital Territory, Nigeria **Word count:** 209

1. Introduction

The Federal Capital Territory (FCT), Abuja is the administrative headquarter of Nigeria carved out of Niger and Kogi States in 1976. It had rich natural forest resources replete with various indigenous species of trees and animals as well as 18 gazetted forest reserves inherited from Niger, a State bounding the FCT on the west (Forestry Department, Federal Capital Development Authority (FCDA), 2013). These forest reserves gave the FCT a very conducive environment of 10% vegetation cover by 1976. Thirty-eight years later in 2014, the vegetative situation has changed due to environmental degradation. The vegetation cover from these reserves is now about 2%. These forest reserves and primary forests have been encroached upon giving way to infrastructural development and human settlements. Some of the economic trees and wildlife are already endangered (Forestry Department, FCDA. 2013). Out of the 10,914.85 hectares of forest reserve that existed in the FCT, only about 1000 hectares remain intact (*see*, Table 1).

Table 1: Present Forest Reserve Status in the FCT.



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1	Gwagwa	237.84	AMAC	colonized by farmers
2	Karmo	513.62	AMAC	Encroached
3	Karon Majigi	228.95	AMAC	Deforested
4	Garki	474.56	AMAC	Deforested
5	Idu	631.20	AMAC	Encroached
6	Kukwuaba	447.87	AMAC	Deforested
7	Galadimawa	697.32	AMAC	Deforested
8	Gaba Zuma	184.93	AMAC	Deforested
9	Chikwoi	27.27	AMAC	Deforested
10	Chihurma	136.09	AMAC	Deforested
11	Kusoru	104.74	AMAC	Deforested
12	Odu	4,322.99	AMAC	Deforested
13	Kuje	89.31	KUJE	Intact
14	Babban Kurmi	372.15	KUJE	Deforested
15	Tukoki	628.46	KUJE	Deforested
16	Shaba	60.91	KUJE	Deforested
17	Buga Hill	736.41	KUJE	Deforested
18	Kujekwa	1,020.03	KUJE	Deforested
TOTAL		10,914.85		

LGA – Local Government Area

Source: Forestry Department, FCDA, 2013.

Prominent among this form of environmental degradation is deforestation which has obvious environmental change and socio-economic impacts on human life. These impacts include loss of agricultural productivity, alteration of the carbon and water cycles. Deforestation also has detrimental effects on vector-borne diseases and leads to loss of biodiversity (Walsh, *et al*, 1993; Fearnside, 2005).

2. Research Problem

Nigeria is well endowed with forest resources, accounting for about 2.5% of the Gross Domestic Product (GDP). These resources provide employment and help maintain the health status of the residents (Olufemi and Ameh, 1999). A major challenge faced by the country is extensive deforestation which occurs at a rate of 3.3% per annum. Since 1990, the country has lost over 6 million hectares or 36% of its forest cover. The most diverse ecosystems (old growth forests) are disappearing at an alarming rate; between 1990 and 2005, 79% of these forests were lost. Since 2000, Nigeria has been losing an average of 11% of its primary forests each year. According to the Food and Agriculture Organization (2001), these losses have resulted in Nigeria having the greatest deforestation rate in the world. Out of the 10,914.85 hectares of forest reserve inherited by the FCT, only about 1,000 hectares currently exist and this excludes all of the primary forests where little or no protection is enforced. Deforestation is largely uncontrollable in the FCT due to the activities of the residents, chief of which is bush burning (Forestry Department of the FCDA, 2013).



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The cultural beliefs of the indigenes and residents of the FCT have a significant impact on deforestation rate in the area. In order to prepare land for cultivation and urban development, these people believe that vegetative clearance has to be done thoroughly without consideration to important role of vegetation in sustaining the ecosystem of the area. The vegetative clearance is often carried out faster by setting the forest on fire. Similarly, poachers and games chasers freely set the vegetation on fire in order to enable them have access to wild animals. Another belief which fosters deforestation in the FCT is the use of wood fuel. The residents are of the view that wood fuel offers a faster burn in cooking and add unique flavour to the food. Indiscriminate burning of vegetation exposes the soil to sunlight which leads to loss of soil nutrients, mosquito breeding and outbreaks of malaria. This study will examine the volume of wood fuel used by residents in cooking as an indicator of the number of trees felled.

The poverty level of the rural dwellers in the FCT also contributes to deforestation. Some rural dwellers engage in timber business which involves illegal lumbering, selling of timber as firewood and to developers who use them for construction purposes. Others convert this timber to charcoal and sell the product to caterers and smiths. The poverty level of these dwellers forces an early harvest of the forest resources with little time for the trees to mature while other plants are often cut down if they have no market value. These activities pose a serious risk to the environment and increases the incidence of diseases such as malaria on the human population. A number of social and health issues associated with deforestation is discussed in the study conducted by Pattanayak et al, 2006.

Another factor which causes deforestation is the lack of enforcement by the relevant authorities. In the FCT, there are no forest guards to monitor the forest reserves and the manner in which the residents exploit the forest resources. Policy-makers and regulators argue that for the law to be enforced, an alternative, especially for wood fuel, must be given to the dwellers to avoid unnecessary conflict between them and the government. The environmental implication of alternative source of wood fuel, like kerosene, cooking gas or electric stoves is a cleaner and better environment. Government, on its own, prefers to spend money managing the consequences of using wood fuel than to spend on prevention by providing alternatives like kerosene stoves, gas cookers and electric cookers. Beyond this, the constant increase in the price of these alternatives and the frequency of their availability is a source of major concern. Most of the residents concerned are not capable of acquiring these cooking equipment and even when they acquire them, they are not sure of the availability of the fuels to use. They, therefore, rely on the best alternative that is readily available and affordable which is the trees in the forests.

Yet another factor contributing to deforestation is indiscriminate logging for timber and wood fuel. Since rural dwellers living close to the forests are highly dependent on wood fuel for their cooking, this puts an inordinate pressure on the forest resources. This ugly trend is worsened by the fact that alternative fuels such as kerosene, coal or cooking gas are either not available or affordable to the residents. The problem of deforestation is further exacerbated through the use of bulldozers for clearing estate sites and road construction leading to the clearance of large portions of forest in few hours thereby resulting in more damage and extraction higher than those approved by regulators. It is noteworthy that within the surrounding settlements, local residents are dependent on bush meat as part of their local staple food supply. Bush meat availability has decreased in many parts of Nigeria with the construction of roads and other infrastructures. Increased access to wildlife habitat places more pressure on forest

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from both hunters and poachers. There is a growing concern among health experts, geographers, social scientists and demographers that the quest for bush meat may be linked to forest degradation. This study, therefore, critically analyse the rate of deforestation in the FCT and cultural reasons behind it.

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3. Review of Literature

Deforestation, according to World Wide Fund (WWF) for Nature (WWF, 2010), is the conversion of forested areas to non-forest land for agriculture, pasture, urban use, logged area, or wasteland. The WWF maintains that deforestation can also be seen as the removal of forests leading to several imbalances ecologically and environmentally which result in decline in habitat and biodiversity. According to Natural Resources Canada (2016), deforestation is an important issue since shrinking forest cover reduces biodiversity, affects soil and water quality, impacts wildlife habitat and influences climate change. The Canadian Government carefully monitors and regularly publishes reports on deforestation and their scientists combine satellite and aerial images with information about regional development, forest ecosystems, natural processes and local conditions to help monitor and manage the health of Canadian forests. At 0.02% of its forested area, deforestation in Canada is among the world's lowest, yet many myths exist about the state of their forests. The reality is that Canada is a world leader in sustainable forest management. Canadian forests are healthy, productive and thriving.

Deforestation comes in many forms, including mining, urbanization, fires, clear-cutting for agriculture, ranching and development, unsustainable logging for timber, and degradation due to climate change (FAO, 2007). Loss of forest cover impacts people's livelihood and threatens a wide range of plant and animal species. Some 46-58 thousand square miles of forest are lost each year and this is equivalent to 36 football fields every minute. Deforestation is a particular concern in tropical rainforests because these forests are homes to much of the world's biodiversity. For example, in the Amazon and parts of Indonesia, around 17% of their forests has been lost in the last 50 years mostly due to forest conversion for cattle ranching (WWF, 2010). Deforestation in the Sub-Saharan Africa which includes Nigeria is particularly rampant near more populated areas, roads and rivers. Even in remote areas, forests have been encroached upon. In the World Wide Fund for Nature Report (2010), forests cover 31% of the land area on our planet. They produce vital oxygen and provide homes for people and wildlife. Many of the world's most threatened and endangered animals live in forests and 1.6 billion people rely on the benefits offered by the forest which include food, fresh water, clothing, traditional medicine and shelter.

Studies carried out by Nobre, Sellers and Shukla (1991), Laurance (1998) and the WWF (2010) pointed out that forests play a critical role in mitigating climate change because they act as a carbon sink which soaks up carbon dioxide that would otherwise be free in the atmosphere and contribute to ongoing changes in climate patterns. Deforestation undermines this important carbon sink function. It is estimated that 15% of all greenhouse gas emissions are the result of deforestation (Riiters *et al*, 2000). Riiters *et al* (2000) further stressed that forests are more than just a collection of trees, they are integrated ecosystems and home to some of the most diverse life on Earth. They also serve as major players in the carbon and water cycles that make life possible. When forests are lost or degraded, their destruction sets off a series of changes that affect life both locally and globally.

3.1. Causes of deforestation





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Joshi and Singh (2002), in their study, attributed the main cause of deforestation to the rapidly growing population. They further contended that more people increasingly depend on forest land for other uses thus forests are being cleared to create land for a multitude of human activities. Joshi and Singh (2002) used a questionnaire to collect their data which was then subjected to content analysis. The analysis showcased a five-point-causes of deforestation which include increased agricultural land use demand, urbanization, improved transport networks, industrial development and fire. Some of the causes of deforestation are critically examined below.

Conversion for agricultural purposes - As the human population increases, there is an obvious need for more food and other necessities of life. In addition, agricultural products such as soy and palm oil are used in an ever-increasing list of products ranging from animal feed to lipstick and biofuels. The rising demand for these products has created incentives to convert forests to farmlands and pasture lands. Agriculture is estimated to be the direct driver for around 80% of deforestation worldwide (Wageningen University and Research Center, 2012). Jordan (2015) also pointed that in the next 40 years, agricultural land will expand by more than an area larger than India and about a third the size of the United States. Therefore, conversion of forest for agricultural purposes is most destructive especially when it occurs in a fragmentary pattern rather than in a consolidated patch. Similarly, in Nigeria, large scale agricultural practices which requires large land capital has also consumed a large portion of forested areas (Ogunwale, 2015). Ogunwale (2015) further asserts that mechanized farming in the middle belt was practiced by indigenous farmers but the system of shifting cultivation is still employed to improve crop yield. This requires shifting from existing farm sites to virgin and uncultivated lands thereby clearing existing natural forests. Even if the best natural forest management systems available could be implemented in Nigeria, the forest reserves would not be able to meet the country's timber needs of 19 million m3 cu in the year 2000. Yields of the natural high forests are about 10-25 percent of the short time yields from plantations. Therefore, the trend is the clearance of primary forest for plantation development which involves removal of both indigenous and exotic timber species often to the detriment of the country's natural forests. Once a forest is lost to agricultural practices, it is usually gone forever along with many of the plants and animals that once lived there.

Fire- Deforestation can happen quickly when fire sweeps through the landscape or the forest is clearly cut to make way for industrial development such as oil palm production. The latter is of particular concern in Indonesia and Malaysia which produce a combined total of more than 50 million metric tons of palm oil per year. Deforestation can also happen gradually as a result of ongoing forest degradation as temperatures rise due to climate change caused by human activities. Fire constitutes a natural and beneficial element of many forest landscapes but they are problematic when they occur in the wrong place, at the wrong frequency and with the wrong severity. While deforestation appears to be on the decline in some countries, it remains disturbingly high in others including Nigeria and this poses a grave danger to our world's most valuable forests.

Illegal logging – Palmer (2000), considered the underlying causes of recent high rates of deforestation in Indonesia. He did this using the Materials Balance Method.

$H_L.A_L =$	Q_{L}	 (1)
$H_T.A_T =$	Q_{T}	 (2)



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Hence illegal logging $Qi = Q_T - Q_L$ (3)

H= harvest quantity, i= illegal, A= area (hectares), T= actual (total), Q= output (m³), L= legal

From the analysis, Palmer discovered that in Indonesia, the fundamental causes of illegal logging are market and government failures often arising as a result of corruption.

Illegal logging generally occurs around the world while, in some places, illegal logging is more common than the legal variety. Illegal logging depresses the price of timber worldwide, disadvantaging law-abiding companies, and depriving governments of revenues normally generated from duties and taxes (Olufemi and Ameh, 1999). Poor communities near forests are often vulnerable when outsiders try to gain control over the timber nearby which can lead to repression and human rights violations.

Fuelwood harvesting - Wood is still a popular fuel choice for cooking and heating around the world and about half of the illegal removal of timber from forests is thought to be for use as fuel wood. The International Union of Forest Research Organisations (2015) itemized reasons why deforestation is on the increase. Some of these reasons include; unsustainable timber extractions including excessive cuttings and poor harvest operations, expansion of agricultural lands and unsustainable agricultural practices, climate change, non-involvement of local communities in land management decisions, exploitation due to weak rule of law and deficient monitoring by enforcement agents and poverty.

3.2. Agents of deforestation

Agents of deforestation are different from the causes. The agents of deforestation refer to those individuals, government agencies, corporations or development projects that clear the forests as opposed to the motivational forces (FAO, 2007). Table 2 shows some of the agents of deforestation and their links.

1	Slash and burn farmers	clear forest to grow subsistence and cash crops				
2	Commercial farmers	clear the forest to plant commercial cash crops,				
		sometimes displace slash and burn farmers who then				
	2	move to the forest				
3	Cattle ranchers	clear the forest to plant pasture, sometimes displace				
		slash-and-burn farmers who then move to the forest				
4	Livestock herders	intensification of herding activities can lead to				
		deforestation				
5	Loggers	remove commercial timber, logging roads provide				
		access to other land users				
6	Commercial tree planters	clear mostly forest fallow or previously logged forests				
		to establish plantations and to supply fibre to the pulp				
	•	and paper industry				
7	Firewood collectors	intensification of firewood collection can lead to				
		deforestation				

Table 2: Agents of deforestation



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8	Mining and	d petroleum	roads and seismic lines provide access to other land
	industrialists		users, localised deforestation related to their operations
9	Land settleme	nt planners	relocation of people into forested areas as well as
			settlement projects displacing local people who then
			move to the forest
10	Infrastructure	developers	new access to other land users from road and highway
			construction through forested areas, flooding by
			hydroelectric dams

Source: Forestry Department, FAO (2007).

In Africa and Nigeria in particular, five main agents of deforestation have been identified. These are slash and burn farmers, commercial farmers, loggers, livestock herders and civil and refugee disturbances (Uneke, 2008).

3.3. Deforestation rate

Tropical forests (including forests in the FCT), which are estimated to contain over half of the global biodiversity, are being destroyed at a significant rate (Laurance *et. al,* 2001). Deforestation in the tropics has been going on for several years but the main damage has occurred during this century since the spread of broad-scale industrialization and plantation agriculture especially in Brazil, and since the rapid population growth in Madagascar (Wilson, 1987). Understanding the dynamics of forest loss is crucial to the effective management and conservation of biodiversity and improving the health status of residents. However, the indices needed to estimate deforestation are often flawed (Dirzo and Garcia, 1992; Fearnside, 1993). In recent years, forest loss is basically measured using satellite imagery and spatial analyses. This study also calculated the rate of deforestation by comparing the areas with dense forest cover in the FCT for 1987 and 2014 and subjecting the data to the FAO model.

4. Methodology

Table 3. Methodology Table.

To assess	Satellite images of	Abuja	Geographic	The 1987 and 2014 forest sizes
the nature	FCT for 1987 and	Geographi	Information	for FCT were subjected to the
and extent	2014. Using	с	System	FAO formula
of	Landsat Thematic	Informatio		$Q = (A_2 / A_1)^{1/(t^2 - t^1)} - 1$
deforestatio	Mapper (TM) at a	n System,		Where $Q = rate$ of
n in the	1000m resolution.	National		deforestation, A_2 and A_1 are
FCT.		Air Space		forest sizes for 2014 and 1987
		Research		respectively.
		and		
		Developm		
		ent		



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Agency and USGS.

This study utilized data on socio-demographic characteristics of respondents (age, sex, *et. cetera*). Other data types include ownership of forests, areas covered by forests, nature of forests, vegetative distribution, number of trees cut per annum, average monthly income, agents of deforestation, alternatives to wood fuel, their availability and affordability, Normalized Difference Vegetation Index, opportunity cost of deforestation, methods of deforestation, satellite images of areas covered by forests and importance of forests. This study utilized data obtained from different establishments using research instruments such as the questionnaire, Focus Group Discussion (FGD), Key Informant Interview (KII), satellite images and observation from the field. Some of these establishments include the Department of Forestry of the Federal Capital Development Authority (FCDA), Abuja Geographic Information System (AGIS), United States Geological Survey (USGS, GLOVIS Viewer) and Google Earth. Primary sources include the Gatekeepers and women in the selected communities. Others came from literature and from GIS reports.

In order to obtain data on deforestation, the list of forest reserves in the FCT was obtained from the Forestry Department of the FCDA (Table 1) and has been listed according to Area Councils. Two Area Councils accommodate these forest reserves namely AMAC and Kuje Area Councils. AMAC initially accommodated 12 reserves out of which two are remaining at Idu and Karmo, while Kuje accommodated 6 out of which one is still intact. All of the vegetation maps, including the Normalized Difference Vegetation Index (NDVI) at a low resolution and the Google Earth Maps at a high resolution, were sourced from the Abuja Geographic Information System (AGIS), the Forestry Department of the Federal Capital Development Authority (FCDA), United States Geological Survey (USGS, GLOVIS Viewer) and Google Earth. This research anchored on the FCT but sampled six (6) settlements (Kuje, Kukwaba, Galadimawa, Idu, Karmo and Buga) to obtain qualitative information. Out of these six communities, three still have gazetted forest reserves (*see*, Table 1) and served as the control sites while in the other three, full deforestation has taken place and they served as treatment sites.

The choice of these six communities is based on the fact that only three gazetted forest reserves out of eighteen, *ab-initio*, still exist in the Federal Capital Territory. These are the two sites in Idu and Karmo respectively and the site in Kuje which served as control sites while two other sites in AMAC, Galadimawa and Kukwaba, and Buga Hill in Kuje have also been selected using a systematic sampling technique hence, they served as treatment sites. The deforested areas in AMAC were listed alphabetically and every fourth community was chosen thus having Galadimawa and Kukwaba selected. In Kuje Area

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Council, Buga Hill was selected. Attention was also given to primary forests. As a result, the satellite images provided information on the sizes of both primary forests and forest reserves. The people that participated both in the KII and FGD were selected through a stratified systematic exercise where the names of qualified people were listed alphabetically and those against even numbers were selected. Three people were purposively chosen from each of the communities for interview using KII. These people were proven to be residents by the qualified gate keepers.



Fig 1. The FCT showing the Area Councils and Communities of study.

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In analyzing the data, two relevant methods were employed; statistical and content analysis. Statistical analysis was employed to analyze deforestation rate in the FCT using the FAO formula. Content analysis was used to analyze all the qualitative data generated from the Key Informant Interview, the Focus Group Discussions and questionnaire. Information include data related to environmental perception, abiding by enforcement policies, and choice of wood fuel for cooking while the FAO formula was applied to calculate deforestation rate.

 $Q = (\bar{A_2}/A_1)^{1/(t2-t1)} - 1$

Where A_2 and A_1 are forest cover at time t_2 (2014) and t_1 (1987) respectively and Q is the rate.

This gave the necessary data for the forests and helped to calculate the rate at which these forests are lost.

The cumulative extent of deforestation [f (t)] is simply the cumulative fraction of an area classified as deforested up to a given year.

The deforestation rate, k, is $f_2 - f_1/t_2 - t_1$

Where f_1 is the cumulative fraction of an area deforested by time 1, and t_1 is the year at time 1. Same goes for f_2 and t_2 . In practice, t_1 and t_2 are often chosen based on the available satellite imageries showing appreciable change. Consistent definition of the rate of deforestation requires unambiguous and preferably automated identification of the beginning and end of clearing (Biggs et al, 2008).

The above model is similar to the FAO model that this study has adopted over any other. According to FAO (1995), deforestation rate Q, can be calculated using the formula;

$$\mathbf{Q} = (\mathbf{A}_2 / \mathbf{A}_1)^{1/(t^2 - t^1)} - 1$$

Where A_2 and A_1 are areas covered by forests at time t_2 and t_1 respectively.

According to Fearnside (1993), and Liu et al (1993), annual rate of deforestation R is given thus $R = A_1 - A_2 / t_2 - t_1$. This gives basic information since it is the average at which the forest is being cut and expressed in unit area per year.

Fischer (1994) and Zhang et al (2003) both agree on a logistic function model. This model is best adapted to describe deforestation time series. $Fs/(1+Ae^{-Bt})$ F(t) =where F(t) is the cumulative fraction of forest cleared by time t, Fs is the stable deforestation extent, while e is the base of the natural logarithm, A and B are fitted parameters. The challenge with this model is that it assumes that the cleared areas remain in pasture or secondary forest status. Another school of thought applies this formula:

DF = nrDeforested pixels

nrForested pixels $(t_2 - t_1)$

where DF = deforestation rate between t_1 and t_2 (year),

 t_1 = start time of deforestation rate calculation (year),

 $t_2 = end time of deforestation rate calculation (year),$

 $nrDeforestedPixels = total number of pixels that changed from forest in year t_1 to non-forest$

in year t₂ and for which t₂ is the first image that does not have missing data inbetween t_1 and t_2 .

nrForested Pixels = total number of forest pixels in image at t_1 for which t_2 is the first image that does not have missing data since t_1 .

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This model requires further training to be able to apply it. Therefore, its cumbersome nature has disqualified it from being used in the course of this study.



Fig 2: Livelihood activities within the FCT. Source: Fieldwork, 2015.

From figure 2, it could be inferred that farming (34%) and petty trading (23%) are two activities that are common in the selected communities of the FCT. Farming and timber business are two activities that contribute to deforestation with more than half of the total population of the local residents (55%) engaging in these activities almost on a daily basis. Only the residents of Galadimawa are known not to engage in timber and logging business. They attributed this to the belief that forest provides housing for the community deities and help to regulate the environment. Other communities that engage in the business of logging expressed that they do so without the fear of regulatory authorities since they also partake in sharing the profit. This gives the loggers undue boldness to continue their business which fosters deforestation.

5.1. Agents of deforestation in the FCT

As already stated, agents of deforestation refer to those organisations or defined groups that engage in the act of cutting down trees at a significant rate or level. Six major agents that were identified to be operating within the six communities include the government, furniture makers, farmers, loggers, cattle-rearers and the market association as in the case of Kuje. The main concern



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here is that most of the farmers do not just cut down the trees, they also burn them thereby causing the trees to die to their roots and totally destroying them. As a result, agents of deforestation like furniture makers and loggers try to reach the trees first before the farmers and this creates an unhealthy competition. Yengoh (2008) supports this by saying that deforestation by agents is caused by competition amongst them ("*if I do not cut these trees first for my benefit, another person will for his and so I must cut as many as I can before it is completely cut by others*"). This implies that the trees are cut down without any opportunity to regrow. The furniture makers whose major merchandise are caskets and couches wait impatiently for some of these trees to mature before cutting them down without any plans of replanting. A woman in Kuje claims that the Furniture Makers Association connive with some staff of the FCDA and pay some illegal taxes to them in order to allow them continue the perpetration of this terrible act.

5.2. Substitutes to wood fuel, their availability and affordability in the FCT

Figure 3 reveals five major substitutes to wood fuel from the study. These include charcoal, kerosene, cooking gas, saw dust and electric stove. Both the gatekeepers and the women from the study communities agree that these five alternatives are available at every nook and cranny of their environment. Among these alternatives, only saw dust and charcoal are affordable and readily available since sawyers and carpenters give it away for almost free so as to create space within their shops for operation. The availability of sawdust and charcoal means that a lot of trees are being cut and seasoned almost on a weekly basis. Women in Galadimawa and Kukwaba agreed that their best option is the use of electric or kerosene stoves since they do not have forests again for wood due to massive deforestation by government to pave way for developmental projects.



Fig 3: Alternatives to wood fuel, their availability and affordability. Source: Fieldwork, 2015.



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5.3. Deforestation rate of the FCT

In order to calculate the deforestation rate of the FCT between 1987 and 2014 using the FAO formula, the areas covered by dense vegetation for the two years were calculated using the Normalized Difference Vegetative Index (NDVI). Dense vegetation here is used to substitute for forest cover while sparse vegetation refers to shrubs and trees that are not clustered. The NDVI showed the sizes in hectares of the areas with bare land, sparse vegetation and dense vegetation which was presented by percentage. A non-uniform interval is experienced between 1990 and 1999 because of lack of data. Table 4 presents the NDVI distribution of eight of the years under study.

Table 4: NDVI for FCT.

Year	Bar	e land	Sparse veg	Dense ve	getation	
	Hectares	%	Hectares	%	Hectares	%
1987	4477.59	0.61	594821.59	81.11	134058.42	18.28
1990	1688.40	0.23	593861.65	80.97	137807.55	18.79
1999	1810.71	0.25	579365.80	79.00	152181.09	20.75
2002	8001.99	1.09	624345.28	85.14	101010.33	13.77
2005	52247.21	7.12	585020.06	79.77	96090.33	13.10
2008	54253.04	7.40	583270.84	79.53	95833.72	13.06
2011	58053.06	7.92	582132.00	79.38	93172.19	12.70
2014	59141.84	8.06	579414.51	79.00	93081.25	12.69
Common Ein	1 dense als - 2015					

Source: Fieldwork, 2015.

It is evident from Table 4 that while the area without vegetation is on the increase, the area with dense vegetation has a downward gradient, therefore showing an inverse relationship. It was also established that a sharp decline in dense vegetation cover occurred almost at the same period (around 1999) with the sharp increase in the area without vegetation. This is attributed to the huge developmental projects (construction of estates, roads and university) that took place during that period.

The forest cover for 1987 and 2014 was estimated at 134,058.42ha and 93,081.25ha respectively. Applying the FAO formula:

$$Q = (A_2 / A_1)^{1/(t2 - t1)} - 1$$

Q = deforestation rate, A2 and A1 represent dense vegetation cover for years 2014 and 1987 respectively, while t2 and t1 represent years 2014 and 1987.

Where $A_2 = 93081.25$, $A_1 = 134058.42$, $t^2 = 1987$ and $t^1 = 2014$.

$$Q = \frac{93081.25}{134058.42} = 0.6943$$

$$\mathbf{O} = (0.6943)^{1/(2014 - 1987)} - 1$$

Q = 0.7204 - 1

Q = 0.279.

- Thus the rate of deforestation for the years under study is 0.279%.

Abuja covers 7333.576km² which is equivalent to 733357.6ha. In 1987, the dense vegetation cover was 134058ha, the implication of this based on the deforestation rate as calculated above is that the FCT has lost within the study period a total 374.023ha of its dense vegetation cover. This implies



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that on the average 13.85ha of dense vegetation is lost each year. There are strong health and environmental consequences associated with this loss and this is evident in the potential loss of biodiversity, increase in surface temperature, disruption of biochemical cycling and increase in soil erosion. The resultant effects of this include food insecurity, emissions that contribute to climate change, loss of medicinal trees, increase in the occurrence of diseases such as malaria and loss of original habitat.

5.4. Reasons for deforesting and forest produce use in the FCT

Several reasons were given for cutting down the trees by the residents of the FCT. The women of Galadimawa and Idu communities stated that they cut down trees to pave way for enough sunlight and aeration so as to ensure maximum crop yield from their farming activities. In the same vein, the Idu gatekeepers indicated they clear the forest to obtain available wood fuel and poles for rural electrification. However, In Kuje, the women indicated that they cut down trees to increase visibility thus curtailing armed robbery and rape incidences within and around the forest area. Moreover, removing forest cover also scares wild animals away into the primary forests surrounding them.

The produce from the forest is traditionally used for furniture making, electric poles, herbs for treating ailments, timber for construction, carving of mortar and pestle and for the construction of temporary houses. The bottom line is to generate income and this was corroborated by Yengoh (2008) who attributed deforestation to income sensitive causes. Consequently, it is believed that whatever drives poverty is capable of driving deforestation.

5.5. Opportunity cost of deforestation in the FCT

The opportunity cost of anything is the value of the best option foregone. The best forgone alternative to cutting down these trees and building houses on the forest land, as in the case with Galadimawa and Kukwaba, is to convert the forests into a regulated forest park or even zoo. The forgone values thus are recreational environments, employment opportunities, good health, regulated temperature and availability of animals for consumption. A gatekeeper in Kukwaba noted that there used to be a stream in the heart of the forest that disappeared following deforestation by the government and other agents. He further expressed that the stream had the powers to heal and restore spiritual status and that those ailments suffered by the residents which now prompt them to visit hospitals could have actually been cured simply by drinking from the stream. This borders on ethical and moral values associated with nature.

According to the gatekeeper in Kuje, global warming is also one of the implications of deforestation and so the opportunity cost could be more favourable environment. He claimed that the rate at which trees are disappearing (both natural and government reserves) probably has contributed to the increased temperature being experienced now.

5.6. Methods of deforestation in the FCT

Several methods of deforestation are prevalent in the FCT. The gatekeepers of Galadimawa and Kukwaba reported that deforestation within their villages was massively done by the government using bulldozers and other heavy machines. The residents of Kuje use electric-driven sawing machine to save time. Idu and Karmo residents prefer burning the plants to their roots claiming it is most effective and



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cheap means of deforestation. Bush burning is really one method that cannot be controlled and destroys trees and plantations in large numbers. When trees are burnt to their roots, it does not offer them the opportunity to regenerate and probably regrow. Other methods adopted by the locals who cut one tree at a time for personal use include the use of machetes, axes and other cutting implements.

5.7. Suggested ways to preserve forests by FCT residents

Chief among the suggestions for forest preservation is the enforcement of existing policies on preservation. The Dakachi of Idu blamed the lack of enforcement on the level of corruption by FCDA staff. He claimed that the furniture makers are a powerful group that will go to any length to get what they want. Therefore, the enforcement agents would prefer to take money from them than face turbulent times even in the office. The women of Kuje strongly believe that the only way to do this will be for the government to fence the remaining forest reserve area completely. This will make it criminal for any unauthorised person found doing anything within the forest. This is in consonance with the view of Laurance (1999) who opined that deforestation occurs when institutions are too weak to control it or create an enabling environment for it. He classified this type of cause as "Institutional Sensitive Cause" involving all weak national and international governance as the root cause of deforestation.

The men of Kuje felt that an outright ban on bush burning by punishing culprits will go a long way in preserving the forests. Again, government support and enforcement of regulations is needed to ensure that wood fuel alternatives are readily available and that areas are properly monitored. The women of Galadimawa expressed that they witnessed the strict measures adopted by the forest guards of old in performing their duties and therefore recommended that bringing back armed guards to manage the forests will be the best way to preserve the forests and their resources. Two gatekeepers from Idu and Galadimawa respectively argued that the problem does not lie in deforestation but in the government not enforcing afforestation. Therefore, reforestation programmes will go a long way towards preserving the forests and benefitting the residents of the communities.

Table 5. Importance of forests.						
Use	No. of respondents	Total no. of respondents	Percentage			
Firewood	128	128	100			
Timber	128	128	100			
Wind breaks	62	128	48.4			
Hunting	98	128	76.6			
Treatment herbs	86	128	67.2			
Fruits	101	128	78.9			
Home for shrines	54	128	42.2			
Space for business	82	128	64.1			
Home for wilds	98	128	76.6			
Controls erosion	96	128	75			

Importance of forests to FCTresidents.

Source: Fieldwork, 2015.





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Mclendon (2014) in her article titled "21 Reasons why Forests are Important" provided some reasons why forests around humans are important. Some of these reasons include serving as home for over 80% of known animal species, producing enough oxygen for human respiration, temperature regulation as well as reducing flooding and erosion. Others include serving as windbreakers, providing raw materials for medicinal research and refilling aquifers. Against the best practices for forest conservation, residents of the FCT generally believe that a major importance is the provision of wood fuel and timber. Other importance includes serving as a source for medicinal herbs and housing their shrines thus ensuring durable peace and tranquillity to the communities.

6. Summary and Recommendations

This study has done a detailed analysis on the extent of deforestation in the FCT within the study period and the results have shown a very significant rate of deforestation. Only three forest reserves out of eighteen survived deforestation to some extent. The dense vegetation size was reduced from 18.28% in 1987 to 12.69% in 2014. The rate of deforestation using the FAO formula turned out to be 0.279% thus leading to the loss of 374.023ha. This represents a loss of 13.83ha *per annum*. This degree of deforestation has a strong health, developmental and environmental implications on the environment and people living there. The nature of the three Forest Reserves showed that some form of degradation has taken place especially in the case of Kuje Forest which has been taken over by the local market. The implication of this degree of disturbance is that some living organisms would have been lost or displaced from their natural habitats.

Serious cultural undertones are also responsible for deforestation in the FCT. The residents agreed that the two most important causes of deforestation are the need to provide firewood and timber. This is worsened by government policy which does not ensure sufficient provision of alternatives especially for firewood. A vast majority of the respondents (85%) agreed that charcoal is available while some of them (70%) agreed that it is affordable. Virtually all the respondents (90%) submitted that kerosene is available, more than half of the respondents (58%) argue its affordability, while the remaining respondents noted that cooking gas is available but not affordable. Another product that is both available and affordable is saw dust from mills. Out of the three alternatives that are available and affordable, charcoal and saw dust are pointers to the fact that serious deforestation takes place in the FCT.

Sequel to the presentations of results and discussions of findings, many measures can be put in place to properly manage the forests in the FCT, Nigeria. These will, unarguably, lead to a better environment which will become more sustainable and promote the health status of the residents. The following recommendations are hereby made.

- 1. Efforts should be geared towards the provision of alternative sources of cooking fuel that are both affordable and environmentally sustainable to the local residents.
- 2. Government should consider the use of forest guards equipped with different best practices' monitoring tools. These guards should be committed and passionate with respect to forest management and should be rid of corrupt tendencies since corruption is considered to be the chief reason why illegal logging and bush burning are tolerated.



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- 3. Developmental projects should consider forest areas in their design and where it overrides public interest and part of the forest must go; reforestation and/or afforestation programmes should be established to make up for forest depletions.
- 4. The authorities of the FCT, ministry of environment and other relevant agencies should make concerted efforts to formulate an appropriate preservation policy for the forests of the FCT and ensure its proper implementation.

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APPENDIX 9. NDVI Map of the FCT for 2014.





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General comments: (as attachment)

1. There is a need for the author to correct some typographical errors in the labels of the figure 2. It should read timber business not timbre business

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EVALUATION OF DIMENSIONAL STABILITY OF *BAMBUSA VULGARIS* SCHRAD EX J. C. WENDL. CULM ALONG THE THREE ORTHOTROPIC AXES GROWING IN NIGERIA

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Abstract

The resulting dimensional changes in wood are one of the major sources of defects in furniture and other wood structure. This paper therefore assesses the shrinkage level of Bambusa vulgaris along the three planes to explore its dimensional stability.

Test specimens of 10cm length and different thickness and width were prepared for this test at the base (5%), middle (50%) and top (90%) of the merchantable length of the culm. They were properly aligned and denoted 'T', 'R' and 'L' for Tangential, Radial and Longitudinal planes, respectively. They were soaked in water for 48 hrs in order to get them conditioned to moisture above Fibre Saturation Point (FSP).Specimens were removed one after the other and their dimensions in wet condition were taken to the nearest millimetre with the aids of veneer slide calliper. The specimens were oven dried to 12% moisture content and their dimensions were taken. Then the shrinkage was evaluated along the three planes and data were subjected to analysis of variance

The Tangential, Radial, Longitudinal and Volumetric shrinkage were 4.55 ± 1.77 , 5.61 ± 2.19 , 0.19 ± 0.12 and 10.35 ± 2.77 , respectively. For longitudinal shrinkage it was 0.11 ± 0.06 , 0.22 ± 0.11 and 0.22 ± 0.15 at the top, middle and base, respectively. It was 6.17 ± 2.35 at top, 5.67 ± 2.07 at middle and 5.00 ± 2.09 at the base for radial shrinkage while the tangential shrinkage was 4.42 ± 1.77 , 4.77 ± 1.88 and 4.46 ± 1.69 at the top, middle and base, respectively. The volumetric was 10.70 ± 2.93 at the top, 10.66 ± 2.66 at the middle and 9.69 ± 2.71 at the base. The result of ANOVA shows that there is significant difference along the sampling height for longitudinal shrinkage, but no significant difference was observed for tangential, radial shrinkage and volumetric shrinkage at 5% level of probability. From this study, it can be concluded that B. vulgaris is slightly dimensionally stable.

Keywords: dimensional stability, Shrinkage, *B. vulgaris*, Tangential, Radial, Longitudinal and Volumetric

1. Introduction

The dimensional changes that accompany the shrinking and swelling of wood are major sources of both visual and structural problems in utilization (Carl, 2012). Shrinking and swelling occur as the wood changes moisture content in response to daily as well as seasonal changes in the relative humidity of the atmosphere, that is, when the air is humid, wood adsorbs moisture and swells; when the air is dry, wood loses moisture and shrinks likewise bamboo (Ahmad, 2000). Various finishes and treatments may be used to slow this process, but, in general, they do not stop it (Carl, 2012). Likewise, air drying and kiln drying the wood do not prevent the wood from subsequently gaining or losing moisture. Thus, wood that is kiln



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dried to 6 percent moisture content and stored in a dry shed outdoors in a temperate climate such as that found in Indiana will regain moisture until it eventually reaches about 12 percent moisture content (Carl, 2012); under the same conditions in a tropical climate, the wood will come to a moisture content of about 16 percent. The changes in the dimensions of wood are of importance to anyone who uses wood, whether for tanks or toys, shoe lasts or ships, because wood readily takes on or gives off moisture, even from the atmosphere. Successful use of wood for exacting purposes under wide variations in atmospheric humidity shows that the problems arising from the shrinking and swelling of wood can be surmounted.

Good practice, in general, requires that efforts be made to reduce the changes in dimensions that take place while wood is in use and to minimize their effects by methods of installation and construction. Fortunately, wood is somewhat plastic, so that it can conform to a certain amount of dimensional changes without serious damage. On the other hand, the stresses developed in shrinking or swelling may cause a great deal of damage. The use of insufficiently dried lumber that shrinks under service conditions commonly results in subsequent checking, opening of joints, loosening of nails, and the warping and distortion of wood structures as a whole. If lumber is dried too far below the moisture content it will reach in use, swelling may cause drawers, windows, and doors to stick.

Sometimes the swelling and shrinking of wood can be used to advantage, as in operating humidity indicators and regulators. Swelling is employed to close seams in barrels, tubs, tanks, and boats, and to tighten handles on tools. This means of tightening is only temporary, however, as it causes compression of the wood followed by greater than normal shrinkage (FPL, 1957).

It is well known that wood is an anisotropic material which presents differential dimensional changes in different structural directions. The change in dimensions as a consequence of changes in the moisture content of wood is of great practical importance in seasoning which has a direct effect on the manufacture of furniture and joinery (Usta and Guray, 2000). Wood swells when it comes in contact with water, therefore it is obvious that wood absorbs water and thus increases in size to incorporate the water. This means that if a dry piece of woodwork is unprotected and comes into contact with water, its dimensions change and the piece of wood might not work as designed, for instance a door frame made from wood could get wet, causing swell and stopping the door from fitting. Wood could also shrink when dried, causing similar problems. Since shrinking of wood can cause so many problems and wood is anisotropic in nature, it is important to determine the shrinkage regime of lignocelullosic material along the three axis to reduce the associated problems. It is therefore germane to assess the shrinkage regime of *Bambusa vulgaris* (commonly available bamboo species in Nigeria) in the longitudinal, tangential and radial directions along the height of the bamboo culms.

Also, as bamboo is one of the oldest building materials used by mankind (Abd.Latif*et al.*, 1990), it has traditionally been used as scaffoldings for low-rise houses, short-span roofs, flooring, door shutters, and as construction platforms. In recent times, bamboo has attracted more attention in view of the need for environmental conservation and wood resource shortage. Bamboo is an eco-friendly plant that grows and matures quickly between 3 to 5 years (Liese, 1987).

According to Gardener (1945), Mathew and Nair (1990), Gnanaharan, *et al.* (1993), and.Latif*et al.*, (1990), the durability and service life of bamboo is influenced by its chemical composition and high starch content. However, appropriate treatment techniques have been developed over time that can be easily adopted even with the available facilities in developing countries. But in the recent past, the dimensional stability of the bamboo growing in Nigeria has not been explored and as can been seen from

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the above, the dimensional stability of bamboo is very important to determine its behaviour in service. Therefore, this paper focuses on the shrinkage of bamboo grown in Nigeria along the three orthotropic directions

2. Materials and Method

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Bamboo culms were harvested from the Asanmagbe stream of Forestry Research Institute of Nigeria, (FRIN) located in Ibadan, Oyo State at the South-western region of Nigeria with latitude 7°22"N and longitude 3⁰53"E. Test specimens of 10cm length and different thickness and width were prepared for this test at the base (5%), middle (50%) and top (90%) of the merchantable length of the culm; the dimensions of the specimens along the sampling height were impossible to standardize due to the tapering of bamboo from base to top, the culm wall thickness and the diameter are larger at the base compared to the top. They were properly aligned and denoted 'T', 'R' and 'L' for Tangential, Radial and Longitudinal planes, respectively in line with Ahmad (2000) (Fig. 1). They were soaked in water for 48 hrs in order to get them conditioned to moisture above Fibre Saturation Point (FSP). When wood looses moisture below FSP, it shrinks and swells when water is absorbed. The percentage change in wood dimension as a result of moisture loss is termed shrinkage (Dinwoodie, 1989). Specimens were removed one after the other; their dimensions in wet condition were taken to the nearest millimetre with the aids of Veneer slide calliper and the dimensions were also taken after oven-dried to a constant weight. Shrinkage of the specimens was measured at 12% MC. Bamboo is assumed to shrink and swell similar to wood, and therefore could be investigated using the standard methods of testing small clear specimens of timber, ASTM D 143-94 (1997). Percentage shrinkages along the three planes were calculated as:

<i>S</i> =	$\frac{D_s - L}{2}$	$P_{\underline{o}} \times 100$ (1)
5	D_{s}	
Where: S	=	shrinkage %
D_s	=	dimension at saturated condition
D_o	=	dimension of oven dry condition
	VS	$=S_R + S_T + S_L.$
Where: VS	5 =	Volumetric shrinkage
S_R	=	Radial shrinkage
S_T	=	Tangential shrinkage
a		

 S_L = Longitudinal shrinkage

The approximation was done in accordance with Dinwoodie, (1989).



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Fig. 1: specimen showing the three directional dimension of Bamboo **Source**: Ahmad, 2000 (adapted)

The experimental design adopted for the experiment was a Randomized Complete Block Design with the individual culm serving as block with five replications. Data were analysed using analysis of variance.

3. Result and Discussion

The longitudinal shrinkage of Bambusa vulgaris was 0.19±0.12%. The highest longitudinal shrinkage was observed in the middle and base of B. vulgaris (0.22±0.11% and 0.22±0.15%, respectively), while the least shrinkage was observed at the top with $0.11\pm0.06\%$; the trend is different radially where the highest shrinkage was observed at the top $(6.17\pm2.35\%)$ followed by the middle $(5.67\pm2.07\%)$ and the least was observed at the base (5.00±2.09%); the radial shrinkage of Bambussa vulgaris was 5.61±2.19%. (Fig. 2). Tangentially, the shrinkage is put at 4.55±1.77%, ranging between 4.42±1.77%, 4.77±1.88% and 4.46±1.69% for the top, middle and the base respectively (Table 1). Ahmad (2000) observed radial shrinkage of Calcutta bamboo (Dendrocalamusstrictus) to be 2.5%, 3.1%, 3.2% and 3.7% at four different locations from the base to the top along the culm height and that of tangential shrinkage to be 2.9%, 3.7%, 3.2% and 3.3%, while that of longitudinal shrinkage were 0.43%, 0.16%, 0.17% and 0.19%. The radial and tangential shrinkage of Bambusabluemeana ranges from 5.4% to 9.5% and 6.4% to 20.1% respectively along the culm length from base to top (Abd. Latif, et al., 1993). The observed changes in wood dimension as a result of shrinkage are unequal along the three structural directions. This behaviour of wood has been documented widely by various authors (Panshin and de Zeeuw, 1980; Dinwoodie, 1981; Lausberg, et al., 1995, Ogunsanwo, 2000, Ahmad, 2000, Erakhrumen and Ogunsanwo, 2009). However, Panshin and de Zeeuw (1980) noted that the geometric disposition of cells along the principal directions and the chemical composition such as ligin are responsible for this observation.

The greatest dimensional shrinkage occur along the tangential plane for conventional wood; shrinkage along the radial plane is considered less while the longitudinal shrinkage has been widely reported to be the least and it ranges from 0.1 to 0.3% (Desch, 1988; Dinwoodie, 1989). This contradicts



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what is observed in *B. vulgaris* as the shrinkage observed in the radial plane is higher than the tangential plane $(5.61\pm2.19\% \text{ and } 4.55\pm1.77\%, \text{ respectively})$. It may be as a result of the fact that bamboo is a woody grass and a monocotyledon wood.

The result for the longitudinal direction is in line with the widely reported result for conventional wood which is between 0.1 to 0.3% and for *B. vulgaris* in this study is 0.19%. Ogunsanwo and Ojo (2011) put the radial shrinkage and tangential shrinkage of *Borassus aethiopum* palm to be 3.66% and 3.84%, respectively. Lausberg, *et al.* (1985) reported that this could have been caused by the presence of ray cells on the radial plane with their horizontally aligned cells producing a restraining effect on radial shrinkage. However, Panshin and de Zeeuw (1980) noted that it is related to the rapid reduction of the microfibrilla angle in the cell wall.

The result of analysis of variance of longitudinal shrinkage shows that there is significant difference along the sampling height, but no significant difference among the blocks (culms). For radial shrinkage, no significant difference was observed in the sampling height and among the blocks (culms) but in tangential shrinkage, no significant difference was observed in the sampling, significant difference was observed in the blocks (culms). The same trend was observed in volumetric shrinkage as a result of changes in sampling heights revealed that there is no significant difference but there is significant for blocks (culms) at 5% level (Table 2).

Parameters	Sampling Height	Mean
Longitudinal Shrinkage	Тор	0.11±0.06
	Middle	0.22±0.11
	Base	0.22±0.15
Mean		0.19±0.12
Radial Shrinkage	Тор	6.17±2.35
	Middle	5.67±2.07
	Base	$5.00{\pm}2.09$
Mean		5.61±2.19
Tangential Shrinkage	Тор	4.42±1.77
	Middle	4.77±1.88
	Base	4.46±1.69
Mean		4.55±1.77
Volumetric Shrinkage	Тор	10.70±2.93
	Middle	10.66±2.66
102.	Base	9.69±2.71
Mean		10.35±2.77

Table 1: Mean (%) for Long	gitudinal Shrinkage,	Radial S	Shrinkage,	Tangential	Shrinkage	and
Volumetric Shrinkage	X	0				

 Table 2: Analysis of Variance for the parameters assessed (Longitudinal 'L', Radial 'R', Tangential 'T' and Volumetric shrinkage 'VL')

		ftab	Fcal			
Sources of variation	Df		L	R	Т	VL



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*=significant at 5% level of probability

ns=not significant at 5% level of probability



Figure 2: Shrinkages along the sampling height

4. Conclusion

Tangential shrinkage increased consistently from the top to the base, while radial shrinkage and volumetric shrinkage decreased from the top to the base. Volumetric shrinkage varied consistently and significantly along the culm height. The radial shrinkage of *Bambusa vulgaris* is not statistically different from tangential shrinkage but a bit higher. Longitudinal shrinkage is very small and is significantly different when compared to the other directions.

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NEED FOR SUSTAINABLE CONSUMPTION IN BANGLADESH

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Abstract

Sustainability has become the buzz word now-a-days. Scarcity of resources and the world population are two reverse words that actually force us to think about sustainability. To meet the need of future generations everyone should act or think in a sustainable manner. For that reason in this study the author tries to generate some ideas to promote sustainable consumption. Secondary information and review of existing literature are the sources of information used to conclude on some problems and prospects of sustainable consumption. At the same time the researcher suggested to solve those problems by building awareness of consumers, making policy and necessary legislation and imposing tax on products etc. Keywords: Sustainable consumption, Legislation, Consumer, Innovation.

1. Introduction

Sustainable consumption is not only searching for greener products or services but also consuming less. Sustainable consumption will be used as extraordinary competitive opportunities for businesses. If we do not change our spending pattern or way of consumption, the world will face the prospect of multiple, interlocking global crises for the environment. Sustainable consumption is a basic requirement for a prosperous, safe and healthy global future for the next generation. Worldwide consumption patterns are not sustainable now. It is clear that efficiency gains and technology advances alone will not be sufficient to bring global consumption to sustainable levels. Changes will also be required to consumer lifestyles, including the way in which consumers choose and use products and services. Achieving sustainable consumption patterns is more technically and politically complex than changing production patterns, because it raises important issues such as human values, equity and lifestyle choices.

Consumers play a very important role for driving sustainable production and play a central role in sustainable development and consumption. This research emphasizes how to promote sustainable consumption in Bangladesh by changing lifestyle, building awareness, and making policy. Consumers can practice sustainable consumption in various ways, by recycling household wastes, purchasing sustainable products, using energy efficient appliances, choosing green electricity tariffs, composing garden and kitchen wastage, conserving water and energy, buying organic foods, retuning electrical good for re-use or recycling, switching transport mode, etc.

Research has sharply shown that consumers from many countries around the world express an interest in purchasing green products (Chan&lau2001). A study in 1990 showed that 82% of Americans were willing to pay more for a product that was environmental friendly (Shrum, McCarty & Lowrey1995.)



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David Allaway (2012) mention in his article, a 2008 report developed by members of World Business Council for Sustainable Development's consumers and sustainable consumption work stream draws a number of conclusions as follows:-

1. "Current global consumption patterns are unsustainable...efficiency gains and technological advances alone will not be sufficient to bring global consumption to a sustainable level. Changes will also be required to consumer lifestyles, including the ways in which consumers choose and use products and services. We recognize the need for business to play a leadership role in fostering more sustainable levels and patterns of consumption, through current business processes such as innovation, marketing and communications, and by working in partnership with consumers, governments and stakeholders to define and achieve more sustainable lifestyles."

2. "Human well-being does not necessarily rely on high levels of consumption many poorer countries achieve levels of life satisfaction that is just as high as their wealthier neighbors. Above a minimum level, there is no apparent correlation between per capita GDP and life satisfaction."

3. "Consumers are increasingly concerned about environmental, social and economic issues, and increasingly willing to act on those concerns; however consumer willingness is not translating into sustainable consumer behavior. A variety of barriers has been identified, such as availability, affordability, convenience, product performance, conflicting priorities, skepticism and force of habit."

4. "There is currently no common understanding of what a sustainable product or lifestyle is. Business may determine the sustainability of a product based on a full life cycle analysis. Retailers, governments and other actors may assess the "sustainability"...of a product based on varying disclosure criteria or societal pressure. As a result of this confusion over who determines the sustainability of a product, choices to edit the availability of certain products are often in conflict. Business, governments and society (including consumers) must work together to define sustainable products and lifestyles."

Most of the consumers in Bangladesh are environment conscious but do not know more about sustainable consumption, they consider it from an individual perspective rather than from a uniform perspective. They lose more gas for saving a diaslai kathi. But after a commercial campaign initiative taken by Government, consumers are more conscious about sustainable consumption than previous time.

2. Review of Literature

Lorek, et al., (2013) stated that for achieving sustainable consumption, two developments must take into consideration: the first one is it requires both an increase in the efficiency of consumption as well as a change in consumption patterns, and the second one is to reduce consumption levels in industrialized countries. Technological improvements and eco-efficiency support a necessary reduction in resource consumption. Once this aim has been met, the second prerequisite, the change in patterns and reduction levels of consumption, is indispensible.

Two perspectives on how to reach sustainable consumption have developed, which the following sections elaborate. They show that the two perspectives are based on different conceptual assumptions. What we term the 'weak sustainable consumption' approach is rooted in market approaches and



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technological optimism. Strong sustainable consumption, in turn, emphasizes social innovation as a starting point and strategically takes a technologically pessimistic position.

Sylvia lorek and Doris A. Kuchs (2004) identified various actors and their behavioral impact on sustainable consumption. Consumers, businesses, Government and international organizations are the actors of sustainable consumption. By changing their views and actions good governance of sustainable consumption can be ensured easily and effectively. Tukker Arnold, et.al (2007) recommend a framework for action to change sustainable consumption production in the food, energy, mobility and housing. They give importance on the actions of the stakeholders involved in the process of sustainable consumption especially Government, consumers and NGO's. As Fuchs and Lorek (2005) have shown with a stakeholder analysis of global sustainable consumption governance, consumers, business and political decision makers both in governments and IGOs tend to find themselves locked into the "more-is-better" paradigm when it comes to consumption (Jackson, 2009; Princen, 2010; Shove and Walker, 2010).

The Brundtland commission (1987) defined sustainable development that meets the needs of present without compromising the needs of future generations. Pearce, Mankandia & Barbier (1989) explain that sustainable development involves devising a social and economic system, which ensures that the following goals are sustained: real incomes rises, educational standards increases, health of nation improves, and general quality of life is advanced.

Pearce (1989) states that sustainable development is concerned with the development of a society where costs of development are not transferred to future generations, or at least an attempt is made to compensate for such costs. A strong 'green' awareness among consumers is needed to overcome acquired (non-sustainable) habits and to facilitate behavioral changes which pave the way for responsible actions (Kahneman 2012; Ruckriegel 2014).

3. Objective of the study

- To get an idea about sustainable consumption.
- To explore the ways to practice sustainable consumption. •
- To find out the problems facing the practice of sustainable consumption.
- To provide some recommendations to overcome those problems.

4. Methodology of the study

This study is mainly prepared by using secondary data and reviewing of existing literature available on sustainable consumption. Secondary data are collected from various journals, magazines, newspapers, weekly publications of newspapers, and from various websites. The collected data are analyzed in the perspective of progress and adequacy of sustainable consumption practices in Bangladesh compared to the global endeavors. The major limitation of the study is that no primary data is involved in the study.

5. Definition of sustainable consumption

Lewis Akenji and Magnus Bengtsson (2014) argue that sustainable consumption and production (SCP) should play a prominent role in the formulation and implementation of sustainable development



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goals (SDGs) and discuss how this could be practically done. Unsustainable patterns of consumption and production have been declared the primary cause of environmental deterioration.

Sustainable or responsible consumption implies the satisfaction of personal needs without an adverse impact on the lives and consumption potentials of present and future generations and complies therefore with the principles of sustainability (Agenda 21, 1992; Belz et al., 2007; Belz and Peattie, 2009).

The Oslo Symposium in 1994 proposed a working definition of sustainable consumption as "the use of goods and services that respond to basic needs and bring a better quality of life, while minimizing the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardize the needs of future generations.

Sustainable consumption is related to the process of purchasing products and services, consuming and disposing, while sustainable lifestyles include a broader set of activities, such as interaction, leisure activities, sports and education, including, but not limited to, material consumption (Mont, 2007).

Sustainable consumption refers to measures to achieve a more equitable distribution of consumption around the world and reduce the overall environmental impact (Hertwich and Katzmayr, 2003).

To meet the better future for the next generation in 1992, the concept of sustainable consumption is established in chapter 4 of Agenda 21. From this the concept is enriching itself day by day.

6. Development of global sustainable consumption governance

(Global) sustainable consumption governance is highly necessary. Unsustainable consumption patterns and levels, in particular in industrialized countries, are perhaps a major cause of environmental degradation in the world today (UNDP1998, World watch 2004).

- 1992-At the United Nations Conference on Environment and Development (UNCED) the i. concept of sustainable consumption is established in chapter 4 of Agenda 21.
- 1994-sustainable consumption symposium in Oslo. ii.
- iii. 1995-Sustainable consumption was requested to be incorporated by United Nations Economic and Social Council (ECONSOC) into the UN guidelines on consumer protection.
- iv. 1997-A major report on Sustainable Consumption was produced by the Organization for Economic Cooperation and Development (OECD).
- 1998-United Nations Environment Program (UNEP) starts a sustainable consumption program v. and sustainable consumptions is discussed in the Human Development Report of the UN Development Program.
- vi. 2002- Creation of a ten year program on SCP in the plan of implementation at the world summit on sustainable development (WSSD) in Johannesburg.
- 2003-The "Marrakech process" was developed by co-ordination of a series of meetings and other vii. multi stakeholder processes by UNEP and UNDESA following the WSSD.

7. Importance of sustainable consumption

Sustainable consumption practice means finding ways to meet needs and desires without depleting natural resources. Practicing sustainable consumption can ensure the environment has resources available long into the future. In most industrialized and developed nations, consumption pattern are not sustainable, because they require too many resources, cause too many emissions, and produce social



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impacts in developing countries. In many developing countries, consumption patterns are unsustainable because the consumption is insufficient to meet basic needs (Sen 1998). They may also be unsustainable because they are based on resource exploitation or cause adverse side effects, such as soil erosion and salinization.

Also, in the developed countries, consumers have more purchasing power, so they have the tendency to misuse it. In the developing nations, consumption patterns can be unsustainable because citizens of these countries may need to exploit their natural resources to meet their basic living needs. It is widely recognized that changing household consumption pattern is essential to achieve sustainable development (Kok et al., 2006 p2744 12).

In view of these challenges, sustainable consumption refers to measures to achieve a more equitable distribution of consumption around the world and reduce the overall environmental impact (Hertwich and Michael, 2004).

8. Rebound effect of Sustainable Consumption

Sustainable consumption has both way impact on the consumer. It reduces the demand for more product as well as increases the purchasing power of the consumer. The effects are as follows:

- Direct/ pure price rebound effects (micro-effect): improved energy efficiency for a particular i. energy service will decrease the effective price of that service and should therefore lead to an increase in consumption of that service. This will tend to offset the reduction in energy consumption provided by the efficiency improvement.
- Income effect (micro-effect): holding the price of commodities constant, the reduction in the ii. cost of an energy service implies the consumer has more money to spend on other goods and services. For example, if the cost to heat a household is reduced through installing a more efficient central heating system, then the household is likely to spend the money saved on other items. This may be a more energy intensive activity such as a holiday overseas.
- iii. Substitution effect (micro-effect): the price of an energy service drops, and so consumers should substitute indefinitely for the cheaper energy service.

Indirect/ secondary effects (macro-effect): other goods and services also require energy, and so iv. total energy will increase in areas not directly affected by the energy efficiency improvement.

Economy wide effects (macro-effect): a fall in the real price of energy services may reduce the v. price of intermediate and final goods throughout the economy, leading to a series of price and quantity adjustments, with energy-intensive goods and sectors likely to gain at the expense of less energyintensive ones (Sorrell and Dimitropoulos, 2008; Hertwich, 2005 and Greening et al., 2000, adapted from Kate Scott, 2009).

9. Ways of practicing sustainable consumption

Eco-friendly living is not so difficult or expensive. By following simple principles to manage power, water, and waste better, we could practice it. Living green means reversing climate change, but also having healthy families, cleaner surroundings and financial savings.





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Bangladesh produces 36 million metric tons of CO2 every year. This figure may be low compared to many other nations, but with population density of 1100/sq.km, pollution control and the sustainable use of resources have become life-and-death issues for Bangladesh.

Tabl	e• Ways of sustainable consumn	tion practice	X
Tabl	Energy saving	Water saving	Waste saving
1.	Switching to energy saving light bulbs. These may cost a little more initially, but they use around a quarter of the power of standard light bulbs and last eight times longer.	Fixing any leaky taps, toilets or water pipes. Even a small drip can add up to a lot of water over time. Research has shown that one dripping tap can cause a loss up to 2000 litres per month.	Not throwing out toxic households waste, such as paint, paint thinner and car fluid, in the garbage or down the drain.
2.	Leaving appliances on standby wastes millions of taka worth of energy annually. As such, always turn appliances off. Switch all lights off on leaving a room.	By washing the car in natural ways- for instance, waiting until it rains.	by taking one's own bangs to grocery store. Take canvas bags rather than flimsy flyaway polythene bags.
3.	Most modern electric appliances consume electrically even when turned off. Switch off wall sockets when possible.	Doing a water audit-don't waste water	By composting food waste and use as nutrient rich soil for kitchen garden.
4.	When using washing machine always make up a full load. Dry on a clothes line.	Only after soaping and shampooing-turn on the shower.	By avoiding products with excess packaging.
5.	Don't buy a freezer that is larger than one needed, especially if anyone lives close to the shop.	Considering a rainwater harvesting apparatus. It is cheap to install.	Always use re-usables: mugs, lunch containers, batteries, pens, razors etc.
6.	Buy a laptop instead of a desktop, if possible. It consumes five times less electricity.	By buying water efficient appliances.	Replacing paper products with reusable ones, and using recycled paper when to use paper.
7.	Checking the computer power system.	Reducing current shower time by one minute-it can save thousands of litre per month.	Print on both sides of a sheet. Avoid printing unless necessary.





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8.	By minimizing printing. Laser printers use more electricity than inkjet printers.	Locating and repairing silent toilet leaks.	Check for errors in a document on screen before printing
9.	Considering using a cold shower rather than using the tub.	By giving water garden on demand, not on schedule.	Segregate waste into biodegradable and non-degradable.
10.	Avoid using cars. Walk or take public transportation whenever possible.	By kicking bottles. Ring filtered water instead of buying water in bottles. The plastic bottles take thousands of years to decompose.	109M

Source: The Star, a weekly publication of The Daily Star, January 29, 2010

10. Examples of sustainable consumption around the world

In Australia and Canada, for saving energy, phasing out of less efficient incandescent has been introduced. Australia was the first country to announce incandescent light bulbs would be completely phased out by 2010 and replaced by florescent models which use about 20% of the electricity to produce the same amount of light. Canada decided to do it by 2012.

For example, almost all automobile companies now have advertising campaigns promoting their concern about climate change and the environmental features of their models – Daimler Chrysler (Fresh Air), Honda (Safe and Environmental), Toyota (Clean Air), Volkswagen (Save Fuel), Peugeot (Flower), Kia (Think Before you Drive). Similarly, many petrol companies are projecting a green image and advertising commitments to preserving nature – BP (Beyond Petroleum), Shell (Gardener), and Total (Dolphin). At the same time, ads for consumer goods stress support of human, labour and social rights – Walmart (Community), Bristol-Myers (Diversity and Success), Unilever (Hopscotch), American Apparel (Sweatshop-free Tshirts), and IKEA (Stuffed Animal).

In Australia, mandatory energy efficiency rating labels, now recognized by more than 95% of consumers, complement Minimum Energy Performance Standards for a comprehensive range of household electrical products. The government introduced mandatory sustainability reporting for corporate pension schemes in 2005, runs an ethical and ecological investment platform aimed at increasing the market for sustainable investments, and is developing an eco-label for green funds. From a successful beginning in 2004, *Das bringt's Nachhaltig* has become a yearly *Sustainability Weeks* event when thousands of retailers throughout the country promote and have special offers on organic, fair trade, and locally made products.

In Canada, Homeowners are encouraged to improve the energy efficiency of their homes through the *ecoEnergy Retrofit* scheme, introduced in 2007, which grants a maximum of C\$ 5000 for this purpose. A *Sustainability Reporting Toolkit* was developed by the government to assist firms in assessing the need to report and creating an effective report in terms of communicating its sustainability practices to consumers.

France (with the United Kingdom) has initiated discussions at the European Union level on temporary variations in VAT taxes according to a product's social and environmental performance as denoted by third-party certified labels. The *Velib* (free bike) programme launched in 2007 placed 20,000



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bicycles at more than 1,000 stations around Paris in the attempt to reduce car traffic and pollution. Also, the French environmental energy agency, ADEME, mounted a television communications campaign in 2005 to mitigate climate change, *Energy Savings: Hurry Up. It's Getting Hot*, where individuals tried to break through consumer apathy and suggested small steps for conserving energy.

Energy consumed in Mexico by household appliances fell by more than 50% due to standards and labels developed for washing machines, refrigerators, water heaters, lights, water pumps, boilers, thermal insulation materials and other household products.

The US Nutrition Labeling and Education Act require labeling on all prepackaged foods in the form of a "nutrition facts panel," including nutrients associated with diet-related disease.

In Denmark, Household water consumption was greatly reduced by a 150% increase in the price of water through a combination of taxes -- water supply tax (41%), VAT (20%), variable water taxes (12%), green taxes (14%), variable taxes (9%), fixed wastewater charge (2%), and State wastewater tax (2%).

In Ireland, a 15 cent ($\in 0.15$) levy on plastic bags reduced consumption of these bags by 92% and promoted the use of reusable bags by the majority of shoppers, with receipts going to a fund used to support waste management and other environmental initiatives.

In Netherland, the local government and NGOs introduced a green loyalty point system called Nu Spaarpas which gives green points for sustainable consumer behavior and allows points to be redeemed for sustainable products and services.

Japan launched its *Cool Biz* campaign in 2005 to lower CO2 emissions by encouraging people to wear casual clothes and businessmen to go without ties and jackets to reduce the use of air conditioning. In United Kingdom, The Climate Change Communication Initiative uses the latest multimedia techniques, including interactive websites, champion blogs, and films, to promote individual involvement in action against climate change under the theme Tomorrow's Climate: Today's Challenge.

11. Examples of sustainable consumption in Bangladesh

Unilever and proctor and gamble, among others have been engaging consumers to change their washing habits in keeping with advances in technologies and detergents.

Deshal bd.com, a leading fashion house in Bangladesh, launched paper made shopping bag for very beginning of their inception as a sign of sustainable consumption. Consumers of this boutique house are happy to purchase from the shop as it is their social responsibility to act sustainably.

12. Problems facing the practice of sustainable consumption

Sustainable consumption practice is not so easy to implement, nor is a matter of overnight task. There are some problems that need to be addressed by all.

Contradiction to economic growth: Consumption of goods drives a strong economy. Consumer consumption drives business consumption which is called derived demand. Business consumption in turn generates economic growth. So, the goals of economic growth contradict the goals of sustainable consumption.



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Low consumer awareness: Most people do not know the environmental cost of the products they buy and the services they use. For sustainable consumption to be promoted, there is first need to overcome ingrained thinking and behavior patterns.

Limited access to green products and services: Bangladesh is a developing country. Here people are not aware about green products and services so that access to green products and services are limited.

Lack of transparency and credibility: In Bangladesh transparency and credibility is very low. As such, there are those who are claiming that their products are green but there are no ways to evaluate whether they are actually sustainable or not.

Few take back mechanisms: Take back facilities of products or services can play a very important role for promoting sustainable consumption. In Bangladesh, take back is now at the introductory phase.

Lack of appropriate waste infrastructure: In Bangladesh no proper waste management is present. About 80% per cent of the waste produced in Dhaka is organic and suitable for composting. As oxygen is a vital part of composting process, this is a much greener way of using up household waste.

No after sales support: After sales services are relevant particularly for technically complex or high maintenance products. Providing after sales services can help to stay in touch with end consumer fostering joint learning to improve existing products and develop new ones. In Bangladesh after sales support services are very low.

13. Recommendations

- 1. Government can undertake campaign to raise awareness of consumers on issues related to sustainable consumption by eco-labeling a product as it works as a consumer information tool. Government of Bangladesh can make it mandatory for all manufacturers to give information of their product's best possible usage in the product labels.
- 2. Sustainability may be used as value to influence the brand image that will in turn increase the sales of the company.
- 3. Consumption pattern should be changed to promote sustainable consumption. Sustainable consumption patterns are patterns of consumption that satisfy basic needs, offer humans the freedom to realize themselves, and replicable across the whole globe without compromising the earth's carrying capacity. Consumers can reuse the product again and again by changing the usage form of the product. A sari can be reused by making it as a bazar bag. Also, the government of Bangladash could ban plastic bags.
- 4. Producers should be encouraged to implement take-back responsibility as well as the consumer to be motivated to return the used products to the producers for recycling the products. Coca-cola introduced this facility for their product, but consumers are reluctant to back the product, for minimizing that problem. They introduced plastic pet bottle which is so harmful for the environment, so the Government of Bangladesh should monitor this matter seriously and should ban plastic pet bottle for all kind of beverages available in Bangladesh.
- 5. The more the company educates consumers on the implicit and explicit value of sustained or conscious consumption, the consumer will become more motivated and informed which will encourage consumers for purchasing the company's product. A Bangladeshi Company Walton is giving necessary information of conscious consumption of the product on the label of the product.



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- 6. Companies should encourage the consumers on practice of sustainable consumption, because they are also the employees of larger organization. These practices could be like using less paper by writing on both sides, making less wastage and saving energy of the organization.
- 7. Government should raise the price of less sustainable products and also impose taxes on consumers who will use less sustainable products. Government can impose taxes on fuel, which will help car emissions, car purchase or registration taxes, household energy consumption taxes, water use and household waste (e.g. waste disposal tax.). During the time of budget preparation, government should give importance on this matter.
- 8. Manufacturers should apply cleaner, ecofriendly design products.
- 9. Government should take initiatives to promote sustainable choice of the customers through making strict legislation. Government of Bangladesh can make necessary laws, amendment, and legislative rule for implementing sustainable consumption practice.
- 10. Dhaka Electricity Supply Authority (DESA) can introduce smart electric meter as a pre-paid billing system.
- 11. Banking sector can introduce green credit card, that is one credit card can be used for various banks transaction.
- 12. Government could make operational agreements on implementation of instruments like green public procurement, stimulating eco-design, etc.
- 13. Government should foster greening innovation systems and support sustainable entrepreneurs. Bangladesh Krishi Bank is giving loan to green entrepreneurs who actually take initiatives for green business.
- 14. Government should encourage sustainable consumption by encouraging the company to use performance standards and labels that maximize damages from products before consumption.
- 15. Companies should use label for providing information about recycling or reusing or recollecting products for further production. Now-a-days environment-friendly companies are using these sign and symbols.
- 16. Government campaigns are frequently aimed at encouraging ecofriendly consumption habits. For example, Japan is building on cultural traditions to promote sustainable packaging and recycling through its 3R campaign.
- 17. Taxes and high price should be imposed over the usage of electricity. Electricity may be taxed upon delivery to the end user; household user should bear more tax burden than industry. During the time of budget preparation this matter should get priority.
- 18. Awareness raising campaign should be introduced among the customers about energy conservation like concert, mobile road show etc.
- 19. Advertising can play a very promising role in promoting sustainable consumption. Other public relation tools such as newspaper, magazines, billboard and radio commercials can be used as a tool for promoting sustainable consumption.
- 20. By producing new knowledge about product usage through behavioral change, especially in dayto-day household routines that affect water and energy use, garbage etc. These changing habits avoid the waste of resources.



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- 21. By Influencing of product choice and home improvement investments through marketing campaign, 'Green products' will be promoted. Small investments may also be necessary, such as installing low-flow showerheads.
- 22. By educating consumer about the best usage of the product like how to use, how to reuse and recycling. Consumer could be motivated to repair faulty product rather than replacing them.

14. Conclusion

Sustainable consumption is a new concept in Bangladesh. People do not know about the concept, but consciously or unconsciously they are practicing sustainable consumption. This research was conducted to get an idea about sustainable consumption and to explore the ways to practice sustainable consumption. This research also revealed some problems and made recommendations to promote sustainable consumption in practice.

Sustainable consumption is the kind of consumption that requires wise use of resources for future consumption. The problems which are associated with sustainable consumption are contradiction to economic growth, low consumer awareness, limited access to green products and services, lack of transparency and credibility, and no after sales support etc. It is still now practiced on an individual basis and not in a uniform way.

If the usefulness of sustainable consumption can be wisely presented to customers, the result will be significant. Sustainable consumption can be practiced by saving energy, water and by wastage management. To ensure sustainable consumption, it is not only the duty of government but also other stakeholders including businesses, customer, NGO and other actors.

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