A Study on Rural Biomass Energy Scenarios in Haor Ecosystem

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Abstract— *The study was conducted in the Project area of LIFCHASA in village Purbo Tethulia under Mohanganj upazila of Netrakona which lies in AEZ 2. A total of 102 households were interviewed using a pre-tested questionnaire to identify the farmers' socio-economic condition, bio-diversity, total biomass production and utilization. Data for the study were obtained through personal interviewing. Four categories of farmer viz. landless, marginal and small, medium and large were included in the study. There were 462 households in the village consisting of 2245 persons with average of 4.86 family-1. In the study area 23 tree, 27 field crop and vegetable and 25 weed species were observed. Biomass of field crops, vegetable and weed was estimated through harvesting methods. Biomass production was unequally proportionate among landless, marginal and small, medium and large farmers. The total biomass estimated in the village was 10.04 t farm-1 year-1 and the total utilization was found 14.55 t farm-1 year-1. The bio-energy was found 111.02 GJ farm-1 year-1 where 54.71 GJ farm-1 year-1 bio-energy consumed as fuel. The relationships between the variables were positively significant with the family size, farm size, annual income and problem faced on biomass production and utilization versus total biomass production and utilization.*

Keywords— Biomass energy, Haor ecosystem, biomass production and its utilization, source, biomass pattern, Haor Ecosystem.

I. INTRODUCTION

Biomass is biological material from living, or recently dead organisms, most often referring to plant or plant derived materials. As a renewable energy source, biomass can either be used directly or indirectly-once or converted into another type of energy product such as bio-fuel. Biomass is the overall plant matter created by photosynthesis. It constitutes man's oldest and most fundamental source of renewable energy. It includes new plant growth, plant residues and wastes. The available forms are: wood, short duration trees, herbaceous plants; residues such as agricultural and forest residues e.g., straw, husks, bagasse, cobs, forest or wood based materials like bark, sawdust, roots and even animal droppings, waste comprising garbage, night soil, sewage solids and industrial refuse (Sharma, 1985).

In Bangladesh, biomass is generally used as food, feed, fuel, fodder, organic manure, building material and as the raw material for cottage industries including ploughs, fishing requirement, bullocks, carts and country boats (ESCAP, 1989). The primary production of living biomass on the earth surface is around 172 × 109 t (dry) year-1 of all the biomass resources, the greatest quantity of which is known as phytomass is formed by plant (Aziz and Jalal, 1982).

In the haor area, biomass plays an important role. Crop grains, pulse, vegetable, spices, etc. are used as human food, bran, straw, leaves, weed, etc. are used for feed, the best portion of straw is used for fodder and the rest is used as fuel or bio-fertilizer/organic manure or for housing materials, etc. About 90% of the fruits, vegetable, fodder and biomass fuel requirement are met by home gardens (Hossain and Bari, 1996). Davidson (1984) observed that over half of the fruits, vegetable and spices grown in home gardens are sold to meet family expense.

In Bangladesh, the forest productivity is very low. It is only 0.5-2.5 m2 ha-1yr-1 in both plantation and natural forests (ADB, 1993). It cannot meet the country demand. According to FAO (1982), in Bangladesh 48% of saw and veneer logs and upto

70% of fuel and 90% bamboos come from villages. Extraction rate from village forests is 8.9% and increment rate is 5% (FAO, 1982). At present the dominant source of biomass in the rural areas is field crops, vegetable, trees, livestock etc. from village forests, roadside and homestead plantation. Home gardens along with marginal waste lands and non-forest lands supply more than 80% of fuel wood in Bangladesh (Gujral, 1990). If not properly managed this reserve will be diminished in the near future. So the village forest resources need to make more productive.

Biomass is closely linked to biodiversity which is dependent on mankind or any living species that lives on earth. The mass of living organisms is as biomass which described population in unit area or a volume of the earth surface. It is more précised that the amount of living matter incorporated into a circulatory system of plants (producer), animals (consumer) and micro-organisms (decomposer) in unit area or volume of habitat. Biomass, therefore, can be trees, grasses, crops, aquatic flora and fauna, agricultural residues, fish, etc. (Hossain and Hossain, 1985). Around the homestead area different varieties of tree including crops, shrubs, herbs and aerial plants are grown in nature. Small poultry and livestock production is also a part of home production system.

According to FAO (1986), home gardens are one of the most elaborate systems of indigenous agro-forestry, found most often in tropical and subtropical areas where subsistence land use systems predominate. According to Linda (1990), the high diversity of plant species in village home-gardens assures continuous production of fruits and vegetable, fuel woods, timber and medicinal and cash crops. Michon et al. (1983) noted that the ecological value that they represent in items of genetic diversity and preservation of species in areas when original forest resources have been largely depleted.

Biomass is the principal source of domestic energy in the country. It has been the primary source of energy for cooking, heating and other basic needs since pre-historic time (Sarhandi, 1985). About half of the population in the present world use biomass for cooking at a rate of 1.3 to 2.5 m3 capita-1 yr-1. In Bangladesh contribution of biomass to meet the total energy demand is nearly 63% (Islam, 1991), as compared to only 37% commercial resources. In rural areas the share of biomass is overwhelming.

Biomass resource is now being depleted very quickly due to population pressure and intensive cropping with the use of high input high output technology. Actually basic information on biomass production and utilization at the community and national level are very scarce and limited. It needs to initiate micro level studies in Bangladesh to generate information and suggest policy to address the existing situations of biomass production and utilization by adopting appropriate techniques and technologies in haor farming systems and other means. Therefore, it is needed to investigate about biomass production and their utilization in haor areas of Bangladesh. With the above discussion, the present study was undertaken into micro level, concentrated on rural biomass energy scenarios in haor ecosystem.

The general objective of the study is to assess the biomass production and its utilization in haor ecosystem. The specific objectives of the study were:

a) To identify the source of biomass energy in the study area.

b) To assess the biomass utilization pattern in the haor ecosystem.

c) To identify ways and means of increasing the biomass energy fuel.

II. METHODOLOGY

This chapter describes the materials used and methods followed in the experiment. The Research Site situated at Purbo Tethulia village in Mohanganj Upazila of Netrakona District. The Research Site was a representative of flood prone *haor* area which covers 932793 ha i.e. about 6.5% area of Bangladesh.

2.1 Study Area:

2.1.1 Location and climate:

The study was conducted in the village Purbo Tethulia belonging to the Mohanganj Upazila in Netrakona district. Netrakona is situated in the northern part of Bangladesh. The upazila is situated at 29 km east from Netrakona headquarters. The village is located 9 km north-east of Mohanganj Upazila. The village lies in AEZ 21 which is Sylhet Basin.

2.1.2 Socio-economic condition:

There are 462 families in the village consisting of 2245 persons. The male is 1145 and female is 1100 persons. The average family member is 4.86. The literacy rate is 35.6 % in the village. The main source of income of the village is agriculture and fishing.

2.1.3 Soil:

The land topography is mainly low land with non-calcareous dark gray floodplain soils. Soils are medium in organic matter content and acidic in reaction. General fertility level is high with high CEC (Cation Exchange Capacity) but P and K status is low. The experimental field was clayey in textured soil having P^H value of 5.61.

2.2 Population and Sampling Procedure:

The village farmers (usually head of the farm) constituted the population for this study. The population constituted 462 households. Among the population, 102 households were selected for sample that follows the random sampling method.

2.3 Preparation of Survey Schedule:

In order to collect relevant information, a survey schedule or a questionnaire was prepared. The schedule was carefully designed keeping the objectives of the study in view. It contained both open and close form of questions. The schedule was prepared in Bengali. Before finalizing the schedule, it was pretested with 15 households for judging the suitability of schedule and necessary correction and modification were done accordingly.

2.4 Collection of Data:

Data for the study were collected through personal interview during July 2012 to June 2013. Before starting collection of data, the Researcher made an advanced appointment' with the people of LIFCHASA Project area in Purbo Tethulia village by the help of the Scientific Officer (LIFCHASA Project). The Researcher explained the purpose of the study and requested necessary help and co-operation in collecting data from the respondents. They provided information from their memory. In order to minimize the response error questions were asked in simple Bengali. After completion of each interview, it was checked to be sure that information had been properly recorded.

2.5 Variable of the Study:

In this study, the independent variables were: age, educational qualification, occupation, family size, farm size, homestead size, annual income. Total production of biomass and total utilization of biomass were dependent variables in the research. The procedure was followed to measure these variables are described below.

2.5.1 Measurement of independent variables:

2.5.1.1 Age:

The age of a respondent referred to the period of time from his birth to the time of interview. It was measured in complete year on the basis of his response to item no. 1 of the interview schedule.

2.5.1.2 Educational qualification:

Education level of a respondent was measured by the number of years of schooling he or she completed. The level of education score of a respondent was determined from his response to item no. 2 of the interview schedule (Appendix II). If a respondent did not know how to read and write his/her name literacy score was taken as zero. A score of one was given to that respondent who could sign his/her name only. Besides this, the respondent was given actual score of 1 for every year of schooling i.e. one for class one, 2 for class two, 10 for class SSC, 11 for HSC, 12 for graduation and 13 for masters.

2.5.1.3 Occupation:

The main income source of respondent in a year was assessed as his occupation. A score of zero was given when his occupation was agriculture and fishing, for service that was 1, for business that was 2 and for other occupation of a respondent's score was 3.

2.5.1.4 Family size

The family size of a respondent was measured by the number of his family member including himself, children, wife and parents.

2.5.1.5 Farm size:

Farm size of respondent was measured by the response to question item no. 5 of the interview schedule (Appendix II). Here farm size expressed as hectare and was computed by the following formula.

Farm size = Homestead area with pond+ own land under own cultivation+ land (1)

Taken from others on lease+1/2(own land given to others on *borga* + land taken from others on *borga*)- Land out to others on lease.

The farm was categorized into four sizes as shown in Table 2.

2.5.1.6 Homestead area:

It was measured by the area of the raised land in which the household has its entire dealing unit including living room, kitchen room, cattle shed, front yard, courtyard bushes, bamboo branches, etc. (BBS, 1987). It was expressed in hectare.

2.5.1.7 Annual income:

Annual income was defined as the total earning of the respondent from field crops, vegetables, timber, livestock, fish, service, business and other source. A score of (1) was assigned for each one thousand taka.

2.5.1.8 Problem faced on biomass production and utilization:

It refers to the problem faced by the respondents from different sources and also through their experiences of biomass production and utilization. The respondents were asked seven questions in item no. eight of interview schedule on different aspects of biomass production and utilization. The total assign score on all the questions was 35. A respondent answering a question correctly obtained the full score while for wrong answer he obtained zero score. A partial score was also given in case(s) of partial correct answer of questions. The total score obtained by the respondent was taken as his problem faced on biomass production and utilization.

2.5.2 Measurement of dependent variables:

2.5.2.1 Total production of biomass household^{-1}:

Total production of biomass household^{-1} was measured by the researcher. It was dependent on the total of different production components of a farm such as homestead trees, vegetables, field crops, livestock, households waste and weed etc. Some expert's opinions were taken by the researcher in this study (discussed later). It was expressed in tones.

2.5.2.2 Total utilization of biomass household^{-1}:

Total production of biomass household^{-1} was measured by the researcher himself with the help of respondent. Some expert's opinions were taken by the researcher in this study (discussed later). It was also dependent on the total of various utilization items such as fuel, organic fertilizers, animal feeds in each homestead. It was expressed in tones.

2.6 Biomass Estimation:

2.6.1 Estimation of biomass from field crops and vegetable:

The total amount of field crops and vegetable of selected farms during July 2012 to June 2013 were estimated with the help of SAAO experts. Biomass and productivity of crops were determined by the harvest method (Odum, 1960). Crops were harvested during their peak growth or ripening stage. First 10 sample plots of each crop/vegetable was selected. Then 5 to 10 number of quadrates (1m × 1m) was taken from each sample plots. The sample was dried in open sunlight then it was estimated in dry basis. The dry weight of sample was converted to hectare basis.

2.6.2 Estimation of biomass from trees in a homestead:

The total weight of leaves, twigs, branches wood etc. of trees homestead^{-1} during July 2012 to June 2013 was surveyed from 102 households in the village. Homestead^{-1} tree biomass was estimated by the Researcher himself with the help of expert's judgment where default values had to be used in each homestead.

2.6.3 Estimation of biomass from household wastes and weeds:

2.6.3.1 Household wastes:

The amount of household waste e.g. cooking waste, cleaning waste etc. (dry basis) were assessed from each household. Based on their opinions, the Researcher observed, weighed dry matter and was expressed in ton.

2.6.3.2 Weed biomass:

The data on weed biomass were taken from different crop lands and also from fallow land. The biomass of weeds was determined using a quadrate of (1m × 1m). The number of quadrate was 3 to 5 in each of five sampled plots for each

crop/vegetable/fallow land. Then weeds were cleaned, washed and air-dried and finally, dried in open sunlight and estimated in dry basis as done in crops and converted to hectare basis.

2.6.4 Estimation of biomass from livestock/poultry in a homestead:

2.6.4.1 Cowdung:

The total number of cattle present household^{-1} in July 2012 to June 2013 in the village was recorded. The quantity of cowdung (dry basis) was calculated by multiplication of the cowdung production head^{-1} year^{-1} and the number of cattle in the village. The cowdung (dry basis) quantity head^{-1} year^{-1} was estimated to 0.49t.

2.6.4.2 Goat faeces:

The dry biomass obtained from goat faces head^{-1} in the village was also estimated by same method as used in cattle. The quantity of biomass was estimated 18.25 kg head^{-1} year^{-1}.

2.6.4.3 Poultry excreta:

Similar method was also used for estimation of poultry excreta. The quantity of biomass was estimated 10.95 kg head^{-1} year^{-1} (Uddin, 1991).

2.6.5 Estimation of fuel biomass:

The respondents were the housewives of sampled farmers or the senior women member of the households. The respondent was asked about the fuel items and total amount of a day, she used usually. Based on her opinion, amount of those fuel items were weighed and was expressed in ton year^{-1}.

2.6.6 Estimation of organic fertilizer and other biomass which was used in selected farms:

The uses of total amount of organic fertilizer and other biomass in selected farms were surveyed and estimated by the researcher based on farmers' opinion and converted in t yr^{-1}.

2.7 Bio-energy Estimation:

After collection of biomass from all the available sources like field crops and vegetables, homestead trees, weeds and animals bio-energy were calculated from each source multiplied by their specific conversion factors. Each and every source had a definite factor that were given in Appendix III.

2.8 Biodiversity:

The farmers of the homestead in the village were asked about the names of trees, field crops, vegetable and weed species. Besides, the researcher himself identified the species diversity through frequent visit in the village.

2.9 Analysis of Data:

After completion of the field survey, the information obtained from all the respondents were coded, compiled, tabulated and analyzed according to the objectives of the study. Local units were converted into standard units. The responses to the questions in the interview schedule were transferred to a master to facilitate tabulation for statistical analysis. Statistical means such as number and percentage, distribution, range, mean and standard deviation were used to find out the relationship between selected variables of the farmers of homestead in Purbo Tethulia village and total production of biomass household^{-1} and total utilization of biomass household^{-1}. Pearson Product Moment correlation was used.

III. RESULTS AND DISCUSSION

In this chapter findings to address the objectives of the study have been presented in following parts- the Selected Characteristics of the Respondents, Biodiversity, Biomass Production, Bio-energy Production, Relationship between Variables and Policy Option.

3.1 Selected Characteristics of Respondents:

In this study, eight characteristics of the respondents such as (i) age, (ii) education, (iii) occupation, (iv) family size, (v) farm size, (vi) homestead area, (vii) annual income and (viii) problem faced on biomass production and utilization.

3.1.1 Age:

The age of the respondents ranged from 25-70 with an average 43.03 years with standard deviation 10.79 (Table 2). The distribution of farmers according to age 52.9% were middle aged, 24.5% old aged and 22.5% young aged. Thus, the majority of farmers were middle aged.

3.1.2 Educational qualification:

The education level of respondents ranged from 0-12 years of schooling with an average of 5.56 with standard deviation 4.43. In this study, 40.2% of respondents had primary level education categories, Agriculture and fish capturing were the major occupation of 62.75% respondents whereas 13.7% of them were illiterate, 28.4% had secondary level and 17.6% had upper secondary level education (Table 1).

3.1.3 Occupation:

The occupation of respondents were classified into four categories that ranged from 0-3 scaling with an average of 0.82 with 1.14 standard deviation.

TABLE 1
CATEGORY AND DISTRIBUTION OF THE SELECTED CHARACTERISTICS OF RESPONDENTS IN THE PURBO TETHULIA VILLAGE JULY 2012 TO JUNE 2013

Variable	Observed Range	Scoring method	Category	Farmer No	Farmer %	Mean	S.D
Age	20-70	Year	Young age(20-35)	23	22.5	43.03	10.79
			Middle age(36-50)	54	52.9		
			Old age(50)	25	24.5		
Education	0-12	Year of schooling (0-13)	Illiterate(no schooling)	14	13.7	5.56	4.33
			Primary level (0-5)	41	40.2		
			Secondary level (6-10)	29	28.4		
			Above Secondary (>10)	14	17.6		
Occupation	0-3	Scaling	Agriculture and fishing capture (0)	64	62.75	0.82	1.13
			Service (1)	13	12.75		
			Business (2)	14	13.72		
			other (3)	11	10.78		
Family size	13-Feb	Number of member	Small family (4)	37	36.2	5.73	2.43
			Medium family (5-8)	53	52		
			Large family (>9)	12	11.8		
Farm size	0-3.15	Farm size	Landless (<0.2 ha)	40	39.22	0.86	0.71
			Marginal and small (0.2-1.0) ha	29	28.43		
			Medium (1.0-2.0) ha	22	21.57		
			Large (>2.0 ha)	11	10.78		
Homestead area	0-.75	Farm size	Small (upto 0.02)	37	36.3	0.24	0.23
			Medium (0.021-0.05)	10	9.8		
			Large (>0.05)	55	53.9		
Annual income	25-210	Take in thousand	Very low income (upto 25)	29	28.4	94.1	55.03
			Low income (26-40)	35	34.3		
			Medium income (41-75)	12	11.8		
			High income (>75)	26	25.5		
Problem faced on biomass production and utilization	0-35	Marking (0-35)	No problem (upto 3)	14	13.7	14.94	10.12
			Minimum problem (4-15)	23	22.5		
			Medium problem (15-25)	29	28.4		
			More problem (>25)	36	35.3		

S.D= Standard deviation

3.1.4 Family size:

The family size scores of the farmers from 2-13 with mean 5.73 with standard deviation 2.43. Most of the farmers (52%) had medium family compared to 36.2% small family and 11.8% farmers had large family.

3.1.5 Farm size:

In the study the farm size ranged from 0.01-3.15 ha with mean of 0.86 and standard deviation 0.709 (Table 1). Most of the farmers (41.2%) had landless followed by 10.78% large, 21.57% medium, and 28.43% small and marginal.

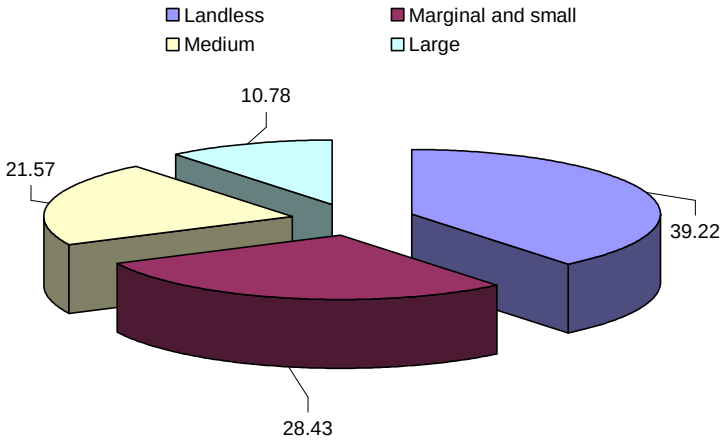

FIGURE 1: Categories of farmers according to farm size in Purbo Tethulia village, July 2012 to June 2013

3.1.6 Homestead area:

The homestead area of the farmer ranged from 0.01-0.75 ha with mean of 0.24 and standard deviation of 0.23. Among the farmers 36.3% was small, 9.8% was medium and 53.9% had large homestead area.

3.1.7 Annual income:

The annual income of the respondents varied from Tk. 25.9 thousand to Tk. 210 thousand with the mean of Tk. 94.10 thousand (Table 1) and standard deviation 55.03. Among the respondents 28.4% was in very low income, 34.3% in low income. 11.8% in medium income and 25.5% of respondents was in high income.

3.1.8 Problem faced on biomass production and utilization:

Knowledge on biomass production and utilization of respondents' sources ranged from 2-32 with mean 25.73 and standard deviation 5.77. The researcher observed that among respondents 13.7% of farmers no knowledge, 22.5% of farmers had minimum, 28.4% of farmer's had medium and 35.3% of farmer's had good knowledge on biomass production and utilization.

3.2 Biodiversity:

3.2.1 Species richness in study area:

In the study area, species richness and diversity were observed at different locations. Among the species, 16 fruit tree, 7 forest, 17 vegetable, 4 spice, 10 field crop species were found during July 2012 to June 2013.

3.2.1.1 Homestead plantation:

A wide variety of trees were found in selected homestead of the village during July 2012 to June 2013 (Table 4). A total number of 23 plant species of 22 families were observed in homestead area of which 16 were fruit species of 15 families and 7 forest species of 6 families. In the study area most available fruit tree species were mango. Jackfruit, litchi, coconut, guava, papaya were found. Among the forest species bamboo, Kadam, mahogani, hijal, karoch, etc. were also observed.

3.2.1.2 Field crop and vegetable:

The field crop and vegetable grown in selected farms in village Purbo Tethulia at different locations (homestead and field) are listed in Table 4. It was observed that 27 species of 13 families of crops and vegetable were grown by the respondents during July 2012 to June 2013. In this area cultivation was mainly crop based but rice was the main crop.

3.2.1.3 Weed vegetation:

In the study area 25 species of weeds belonging to 15 families were found which are given in Table 4. Farmers of the village opined that weed infestation was more in *Boro* season than in other seasons.

3.2.2 Livestock population:

The total number of cattle, goat, and duck and chicken in homestead were 527, 168 and 1102, respectively with 5.17, 1.65 and 10.80 farm^{-1}.

3.3 Biomass Production:

Biomass production is a flexible issue. It varies with land type, season, climate, soil, and other physical and biological environments. It also varies with farmers' choice, cultural, socio-political and socio- economic condition. In this study, the biomass production was estimated on field crops and vegetables, homestead plantations, weeds, household wastes and livestock excreta etc.

TABLE 2
TOTAL AMOUNT OF BIOMASS OBTAINED FROM DIFFERENT FIELD CROPS AND VEGETABLE ACCORDING TO FARM SIZE AND THE AMOUNT OF ENERGY OBTAINED FROM THE FIELD CROPS IN SELECTED HOMESTEAD OF PURBO TETHULIA VILLAGE, JULY 2012 TO JUNE 2013.

Field crops and vegetable biomass/Farm size	Estimated field crops and vegetable biomass production (t)**				Total biomass (t)	Estimated total bio-energy (GJ)*
	Large	Medium	Marginal and small	Landless		
Rice	58.99	56.85	43.03	5.52	164.39	2751.89
Dhaincha	1.32	0.81	0.36	-	2.49	48.01
Jute	2.36	1.32	-	-	3.88	76.13
Other (field crops and vegetable)	55.83	45.62	42.32	8.48	152.25	2987.15
Total	118.5	104.6	85.71	14	323.01	5863.18
Average farm^{-1}	10.77	4, 75	2.95	0.35		57.48

**** 1 t of rice biomass =16.74 GJ***
**** 1 t of dhaincha biomass =19.28 GJ***
**** 1 t of jute biomass =19.62 GJ***
**** 1 t of other crop and vegetable biomass biomass =16 GJ***

TABLE 3
TOTAL AMOUNT OF BIOMASS AND ENERGY FROM TREES ACCORDING TO FARM SIZE IN SELECTED HOMESTEADS OF PURBO TETHULIA, JULY 2012 TO JUNE 2013

Farm size	Estimated biomass		Estimated total energy (GJ)*
	Total	Farm^{-1}	
Large	20.23	1.84	303.45
Medium	21.85	0.99	327.75
Small and marginal	21.82	0.75	327.3
Landless	3.36	0.08	50.4
Total	67.26	-	1008.9

**** 1 t wood biomass = 15 GJ***

3.4 Bio-energy Production:

Bio-energy obtained from different sources in homesteads of Purbo Tethulia village are shown in Fig 10. In the study area, annual total production of bio-energy was estimated to 11324.11 GJ that was 111.02 GJ farm^{-1}. It came from different sources of biomass. The estimated energy obtained from different crops varied 15.79 GJ in banana to 19.28 GJ in *dhaincha.* The highest energy estimated 5863.18 GJ from rice biomass and the lowest 36.96 GJ from goat biomass. The total bio-energy obtained from field crop and vegetable in 102 selected homesteads was estimated 5863.18 GJ yr^{-1}.

Total tree bio-energy obtained in selected homesteads area 1008.9 GJ yr^{-1}. The total energy obtained in selected area from weeds and household waste was 3038.17 GJ yr^{-1} where 2458.46 GJ yr^{-1} from weeds and 487.14 GJ yr^{-1} from household waste

(Table 8) and from the livestock population in 102 selected homestead was 1413.86 GJ $yr^{-1.}$ Data in Table 11 indicated the total energy from different sources $farm^{-1}$. On the average 57.48, 9.89, 13.86 and 329.79 GJ $farm^{-1}$ yr^{-1} bio- energy were produced from field crop and vegetable, homestead plantation, animal excreta and homestead waste, weed, respectively.

TABLE 4
TOTAL AMOUNT OF BIOMASS AND ENERGY FROM WEEDS AND HOUSEHOLDS WASTE ACCORDING TO FIRM SIZE IN SELECTED HOMESTEADS OF PURBO TETHULIA, JULY 2012 TO JUNE 2013

Farm size	Estimated biomass (t yr^{-1})				Estimated energy (GJ)*yr^{-1}		
	Weed biomass	Household biomass	Total biomass	$Farm^{-1}$	Weeds	Household waste	Total
Large	27.2	18.56	45.76	4.16	353.6	107.65	461.25
Medium	66.47	30.1	96.57	4.38	864.11	174.58	1038.69
Marginal and small	85.25	32.09	117.34	4.09	1109.25	186.12	1295.37
Landless	10.2	3.24	13.44	0.33	132.6	18.79	157.5
Total	189.03	83.99	273.11	-	2458.56	487.14	3038.17

**** 1 t weed residue = 13 GJ energy***
**** 1 t dry household waste = 5.8 GJ energy***

TABLE 5
BIOMASS AND ENERGY FROM ANIMAL EXCRETA ACCORDING TO FIRM SIZE IN SELECTED HOMESTEADS OF PURBO TETHULIA VILLAGE, JULY 2012 TO JUNE 2013

Farm size\Biomass	Biomass estimation (t)			Total t yr^{-1}	$Farm^{-1}$	Estimated total energy (GJ)
	Cattle	Goat	Poultry			
Large	11	1.2	3.2	15.4	1.4	215.6
Medium	25	0.6	4.85	30.45	1.38	426.3
Marginal and small	39.63	0.84	9.25	50.93	1.75	676.2
Landless	1.7	0.16	2.34	4.2	0.11	58.8
Total	77.33	2.8	19.64	100.99	-	1413.86

**** 1 t of dry animal excreta = 14 GJ.***

3.5 Biomass Utilization:

In the study area, biomass was used in various purposes as bio-fuel, organic fertilizer and other purposes. Utilization of biomass for other purposes included animal feed, animal bedding, housing materials, mulching etc.

TABLE 6
BIOMASS PRODUCTION $FARM^{-1}$ IN PURBO TETHULIA VILLAGE, JULY 2012 TO JUNE 2013

Source/Farm size	Total biomass production (t $farm^{-1}yr^{-1}$)				
	Large	Medium	Small and marginal	Landless	All
Field crops and vegetable	10.77	4.75	2.95	**0.35**	4.71
Homestead plantation	1.84	0.99	0.75	0.08	0.92
Household waste and weeds	4.16	4.38	4.09	0.33	3.25
Livestock excreta	1.4	1.38	1.75	0.11	1.16
Total	17.11	11.5	9.54	0.87	10.04

TABLE 7
TOTAL ENERGY VALUE PRODUCED FROM DIFFERENT BIO SOURCES IN SELECTED HOMESTEADS AT PURBO TETHULIA VILLAGE, JULY 2012 TO JUNE 2013

Source\Energy	Total energy produced (GJ yr^{-1})	Estimated annual energy (GJ $farm^{-1}$)
Field crops and Vegetable	5863.18	57.48
Homestead Plantation	1008.9	9.89
Household waste and weeds	3038.17	29.79
Livestock excreta	1413.86	13.86
Total	11324.11	111.02

TABLE 8
SOURCE AND UTILIZATION OF BIOMASS IN THE STUDY AREA OF VILLAGE PURBO TETHULIA, JULY 2012 TO JUNE 2013

Source of biomass	Product	Utilization
A. Field crops and Vegetable	a. Rice straw	1. Animal feed
		2. Animal bedding
		3. Mulching
		4. Housing material
		5. Fuel
	b. Rice polish	1. Poultry
		2. Cattle feed
	c. Rice husk	1. Fuel
		2. Poultry bedding
	d. Jute stick	1. Fuel
	e. Mustard plants	1. Fuel
	f. Vegetable plants	1. Fuel
	g. Weeds	1. Fuel
		2. Fodder
		3. Compost
B. Homestead plantation	a. Leaves, twigs and branches	1. Fuel,
		2. Fodder
	b. Wood	1. Furniture
		2. Fuel
C. Animal excreta / waste	a. Cowdung	1. Manure
		2. Fuel
	b. Poultry excreta	1. Manure
	c. Cattle bedding material	1. Compost
	d. Goats faces	1. Manure
D. Household waste	a. Kitchen waste	1. Manure
		2. Animal feed
	b. Cleaning waste	1. Compost

3.6 Total utilization of biomass:

The total amount of biomass utilization in selected homestead with bio-fuel, organic fertilizer and other purposes are shown in Table 15. It shows annual biomass used 14.89 t farm^{-1}. According to farm size, large farm used more (20.75 t farm^{-1} yr^{-1}) than others. The landless, marginal and small, and medium used 1.53, 16.24, 21.78 t farm^{-1} yr^{-1}, respectively.

TABLE 9
BIOMASS UTILIZATION IN SELECTED HOMESTEADS AT PURBO TETHULIA VILLAGE, JULY 2012 TO JUNE 2013

Purpose	Biomass utilization t farm^{-1}yr^{-1}				
	Large	Medium	Small and marginal	Landless	All
Bio-fuel	6.31	6.98	5.77	0.95	5
Organic fertilizer	8.16	8.21	4.92	0.25	5.39
Other (animal feed, animal bedding, housing materials etc)	6.25	6.59	5.55	0.33	4.16
Total	20.75	21.78	16.24	1.53	14.55

3.7 Problem Faced by the Farmers on Biomass Production and Utilization:

The major problem by the farmers on biomass production and utilization was sometime decomposition of biomass by rain opined by 65% respondents, who felt the problem of "wet fuel materials caused severe problem for fire". Some of the respondents (38%) said that insects and diseases were increased by the manure or organic fertilizer and storage problem (due to lack of labour) also found in 65% respondents. Some respondents (45%) measured other problems like flood caused unfavorable effect on trees, crops and animals which were the source of biomass. somewhere stolen problem, sometime epidemic exposes on livestock, crop fields etc. 10% of respondents mentioned that they did not feel any problem on production and utilization of biomass.

TABLE 10
PROBLEM FACED BY THE RESPONDENTS ON BIOMASS PRODUCTION AND UTILIZATION IN SELECTED HOMESTEADS OF PURBO TETHULIA VILLAGE, JULY 2012 TO JUNE 2013

Problem	% of respondents
1. Biomass decomposed by rain some time	65
2. Increased intensity of insects and diseases by the manure/ organic fertilizer	38
3. Storage problem due to lack of labor	65
4. Wet fuel materials caused severe problem for fire	70
5. Other	45
6. No problem	10

TABLE 11
FARMERS' CHOICE IN SITE SELECTION FOR TREE PLANTATION IN SELECTED HOMESTEADS OF PURBO TETHULIA VILLAGE, JULY 2012 TO JUNE 2013

Place of tree plantation	% of respondents
Homestead area	98
Crop land	5
Other (Road side, river bank)	15
No response	3

3.8 Relationship Between the Selected Characteristics of the Farmers vs. effect of their Total Production of Biomass and Total Utilization of Biomass:

This section deals with the relationships between selected characteristics (independent variables) of the respondents and effect of their total production of biomass and total utilization of biomass (dependent variables). Pearson's Product Moment Correlations Coefficient "r" was used to test the hypothesis concerning the relationship between two variables and 0.05 level of significant was used. A null hypothesis rejected when the observed "r" value was greater than tabulated value of "r" at 0.05 percent level of probability. The possible correlation between 8 independent and 2 dependent variables are presented in Table 18.

TABLE 12
RELATIONSHIP BETWEEN THE SELECTED CHARACTERISTICS OF THE FARMERS VS. EFFECT OF THEIR TOTAL PRODUCTION OF BIOMASS AND TOTAL UTILIZATION OF BIOMASS

	Computed ' r value (df = 102)	
Characteristics	**Total production of biomass**	**Total utilization of biomass**
Age	0.476**	0.381**
Education qualification	0.488**	0.403**
Occupation	-0.074^{NS}	0.195*
Family size	0.105^{NS}	-0.225*
Farm size	0.871**	0.567**
Homestead area	0.311**	0.238*
Annual income	0.555**	0.281**
Problem faced on biomass production and utilization	-0.026^{NS}	-0.057^{NS}

***** = Significant level at 1%***
**** = Significant level at 5%***
NS = Not Significant

IV. CONCLUSION AND RECOMMENDATION

In Bangladesh, population growth is high but per capita land area is decreasing day by day. The growing population need food, fuel-energy, shelter, etc. which need biomass resources. The biomass production increases with the increasing farm size. It also competes with the biomass utilization. There exists conflict between fuel and organic fertilizer. Bio-energy puts great stress on biomass resources. A severe imbalance between production and utilization of biomass as fuel prevails in the village and ultimate pressure face by the poor farmers specially the landless. Biomass production was not equally proportionate among large, medium, small and landless farmers. It might be due to the difference in ability, technology know-how and variation in land resource of the farmers.

From the study it is evident that farmers from all categories had to maintain the useful energy status for their livelihood. But scarcity of fuel wood and lower utilization efficiency caused much hardship for the farmers specially poor farmers. The most alarming situation was that cowdung and households waste were mostly used as fuel instead of maturing in crop field. The possibility intervention by homestead agro-forestry practices should be considered as the urgent awaiting thought.

The study suggested to:

a) Increase biomass production through creating awareness about energy crisis among general people.

b) Judicious and efficient use of biomass energy with the improved Chula to overcome this situation.

c) Government initiative is needed.

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